# Labor market inequalities, skills and the geography of jobs : French evidence

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## Labor market inequalities, skills and the geography of jobs: French evidence
Inégalités, qualifications et géographie des emplois sur le marché du travail en France

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# Contents

# General introduction

This thesis falls within the scope of labor economics, economic geography and urban economics. It investigates labor market inequalities and determinants of the location of jobs, workers and firms.

The issue of inequalities goes well beyond economics and there is much debate about how much society should try to reduce them. But, although societies arbitrate differently between an objective of equal opportunities and of equal situations, inequality is a shared concern. Indeed, the United Nations goal number 10 is explicitly to "reduce inequality within and among countries". And numerous policies aim at reducing them : many countries have progressive income taxation or a form of guaranteed minimum income for instance and there are also many programs of international development assistance. Understanding the determinants of inequalities is therefore crucial and it has been largely studied, but it is still a much debated topic. A perfect example is the book from the economist Thomas Piketty, *Capital in the Twenty-First Century*, which analyzed wealth and income inequality in Europe and the United States since the 18th century, and has been a great sales success and at the same time much criticized. Income and wealth are not the only dimensions of inequalities; they are other important ones regarding health for instance that also contribute to well-being inequalities. Nonetheless, income inequalities are an essential component of inequalities and labor market inequalities are a major determinant of income inequalities. Furthermore, space is an important and visible dimension of inequalities. Within cities, there are segregation issues between poor and wealthy neighborhoods in developing countries as well as in developed countries. Urban policies have been implemented for several decades to overcome this segregation. There are also inequalities between cities or countries and economists seek to understand why some places develop more than others, what are for example the conditions of success of clusters of innovation such as the Silicon Valley. The potential benefits of agglomeration are numerous : knowledge spillovers, labor market pooling, positive peer effects but the increasing concentration of people and wealth in a few cities also raises concerns about the effect of congestion on health and on the environment. More generally, there is a lot of ongoing research on spatial externalities, either positive or negative. The purpose of this work is to contribute to the understanding of some determinants of labor market inequalities and, in particular, of spatial labor market inequalities, with empirical studies on the French case.

**Economic issues**

The first part of this thesis investigates two determinants of the location of jobs and workers using two public policies. In theoretical models, the location of jobs and workers is broadly a result of equilibria on the labor market and on the housing market, which depend on transport costs, relocation costs and local advantages. The first chapter studies a urban policy program

and the second chapter deals with a transport infrastructure. Both of them are therefore dealing with spatial equilibria, within cities in the first chapter and between cities in the second.

The first chapter analyses a place-based policy, the French Enterprise Zone program, which has been implemented in the 1990's after similar programs developed in the US and the UK. This program grants very large tax exemptions to firms located in deprived urban neighborhoods. These exemptions are conditioned on a local hiring condition : a share of the workforce of the firms has to reside in the enterprise zone. Indeed the purpose of this program is to improve the situation of the residents of these neighborhoods, by impacting spatial equilibria within urban labor markets. This is done by giving advantages to these zones and it is therefore a form of territorial affirmative action and has a redistributive aspect. This type of policies is also closely related to the issue of spatial mismatch. The spatial mismatch hypothesis is based on the idea that the deprived situation of residents of some places relatively to other places is due to spatial phenomenons, and in particular to the fact that being far from jobs increases difficulties on the labor market. The analysis of the French EZ program performed in the first chapter allows to shed light on these urban labor markets mechanisms.

The second chapter studies French High Speed Rail line openings and the impact of a reduction in travel time between cities on the spatial distribution of workers between different local labor markets. It therefore gives elements on the way transport costs impact spatial equilibria between cities or markets. Core models of economic geography have been dealing with transport cost reduction and more generally trade barrier reduction. They model the equilibria between local labor markets as result of agglomeration and dispersion forces. Transport cost is a dispersion force : if it is costly for firms to transport goods, they locate closer to the demand for their products to save on transport costs and they are therefore geographically dispersed if they serve several markets. Krugman and Venables (1995) model describes the bell-shaped curve relation between trade barriers and spatial inequalities. As transport cost decreases, first inequalities increase between the core and the periphery and after a certain threshold, they start to decrease. Therefore the effect of a decrease in transport cost on spatial inequality depends on the step where is a given economy. Moreover, the effect of High Speed Rail might be specific since it transports mainly people : it can also be seen as a communication cost. The economic geography model of Duranton and Puga (2005) predicts that a decrease in communication cost leads to an equilibrium where cities or local markets are specialized by industry to an equilibrium where they specialize by functions. Since managers need less to be located close to the production sites as the communication cost decreases, firms tend to prefer to locate their headquarters in the same cities as other headquarters to take advantage of local agglomeration externalities (proximity to suppliers of business services). Hence some agglomerations specialize in head-

quarters and business services. High Speed rail line openings allow us to study the effect of a decrease in communication cost on the organization of geographically dispersed firms.

The second part investigates the effect of labor market supply and demand forces on wage inequalities and it uses the comparison with another developed economy, the US one, which is likely to experience similar market forces. And, since education level is a strong determinant of individual labor market achievement, it focuses on labor market inequalities by education level. In the US, main explanations for the rise in wage inequalities between education levels since the 1980's relates to trade or technology. Since France experienced also both an increasing openness to global trade and a dissemination of Information and Communication technology, we expect to find similarities with the US trends if these explanations are relevant.
In order to understand dynamics of wage inequalities by education level over time and space, the third chapter analyzes labor supply and demand by education level at the national level and at the level of local labor markets. It presents new stylized facts for France and compares them to the US.
The fourth chapter investigates one market factor, Skill-Biased Technical Change, that could explain the observed dynamics. More precisely, it tests the assumption that Information and Communication Technology leads to a computerization, which favored high-skilled workers, using differences between local labor markets. Predictions of a model of Autor and Dorn (2013) are tested on the French case. They model spatial equilibrums of local labor markets focusing on high-skilled and low-skilled workers and the task content of jobs. In their framework, high-skilled workers perform abstract tasks and are mobile between markets. Low-skilled workers performed routine and manual tasks and are not mobile. The production of the good requires abstract and routine tasks and they are complementary in the production function. The production of services requires only manual tasks and has to be consumed locally. ICT is modeled as a fall in the price of computers that can performed routine tasks. Hence ICT is complementary to high-skilled abstract jobs and substitute to low-skilled routine jobs. Within this framework, a fall in computer price has different impacts on local labor markets according to the local importance of routine tasks before the development of ICT and this gives testable predictions on the local dynamics of job contents. This model focuses mainly on the "information" part of ICT and its impact on job contents but the "communication" part can have an effect on labor market equilibria and, in particular, on spatial equilibria. Indeed, in the second chapter, we analyze the effect of a decrease in communication costs related to workers travel time but a similar reasoning holds with a decrease in communication costs induced by ICT, i.e it may lead to a functional specialization of local labor markets. The fourth chapter therefore also investigates the effect of this channel on local labor markets dynamics of job contents.

**Methods**

Methods used in the first part are related to the Difference-in-Difference method. The idea is basically to compare a group impacted by the policy, the treated group, to a non impacted group, the control group. By assuming that the treated group would have evolved like the control group if the program had not been implemented, one can evaluate the effect of the program on the treated group. For the enterprise zones program, the residents of the treated zones are compared to residents of other priority zones that did not benefit from the program but were very similar. For High Speed Rail line opening, we focus on the effect of rail travel time on the spatial organization of the workforce within groups. More precisely, we study the impact of travel time to the headquarters on remote affiliates. Our treated group are the affiliates for which rail travel time to their headquarters decreased with HSR line openings between 1993 and 2011. Our control group are affiliates of the same local labor market for which this travel time did not change. It is a variation of the standard DD approach as we control for affiliate fixed effects and local fixed effects interacted with time to control for local demand shocks. These methods allow us to infer a causal effects of the studied policies.

The empirical approaches of the second part are quite different. Relationships between economic outcomes are derived from theoretical models and then tested empirically. First an aggregate labor supply and demand model by education level is estimated at the national level. Using estimations of the supply and wages of high-educated workers relatively to low-educated workers on the period 1967-2009, we infer trends of the demand for high-educated workers relatively to low-educated workers. Then, using a theoretical model of local labor markets, we also estimate the spatial dynamics of the demand for high-educated workers relatively to low-educated workers. In the last chapter, we test predictions of a theory that models the effect of computerization on spatial inequalities between high- and low-educated workers.

**Results**

From the empirical studies performed in this work, we can draw a few conclusions. The first chapter gives an empirical evaluation of the French enterprise zone program. Enterprise zones are a very popular tool in developed and developing countries but there is no consensus on their efficiency. No clear conclusion can be drawn from existing studies. This is mainly due to the fact that their effects are very complex and that the numerous existing programs have different features. Empirical evaluation is therefore needed. In France, there has been one program since 1997. Previous research shows that firms created jobs as a response to the program but there are almost no studies on the effect for residents. In particular, there is no result on the effect on the social composition of the zone that might change if residents move in or out of the zones in response to the program. We perform an analysis on the 1993-2007 period and show that there

has been a significant effect of the EZ program on local unemployment. It first benefited local residents but, with the strengthening of the local hiring condition, the social composition of the zones changed : the share of residents with a high level of education increased. It hints that workers were not very mobile in the short run, but that adjustments took place in the long run. It also shows that spatial mismatch is not the only issue to explain the deprived situation of the residents since bringing jobs closer was not enough to improve their situation. The first chapter shows therefore that EZ programs can have an effect in the short run for residents but that, in the long run, a new spatial equilibrium arises as workers move. So EZ programs reduce spatial inequalities but in part through a displacement of workers and therefore they might not increase global welfare.

The second chapter gives an estimation of the impact of rail travel time on firm management and spatial organization. High Speed Rail infrastructure is very costly and there are almost no empirical evaluation of its effect. With the increase of budgetary constraints, its utility is much debated. The results show a decrease of the share of managers and an increase of production occupations in affiliates which are related faster to their headquarters. There is also evidence of an increase of the share of managers of the group in the headquarters, when average travel time to affiliates decreases. This therefore shows that decreasing travel cost between local labor markets leads to a centralization of high-skilled and support functions in central cities. This might be an unexpected outcome for periphery cities which are often expecting positive returns from HSR line openings. But this study is investigating only one specific aspect of the potential effects of HSR and periphery cities might benefit form HSR lines through other channels.

The third chapter documents a decrease in wage inequalities by education level in France between 1967 and 2009. It shows also, that, similarly to the US, a shift of the labor demand towards high-educated workers occurred on that period but, that it was hidden by an important increase in the supply of educated workers. As trends of the demand are similar between France and the US, market factors common to both economies rather than institutional factors are likely to be the cause of this shift. Moreover, the level of education is stabilizing and it is therefore possible that wage inequalities by education increase in France in the future as they already do in the US. This chapter also shows that, since at least the 1980's, high-educated workers concentrated in local labor markets where their share in the workforce was already higher. And it also shows that it is partly due to an increase in the demand for high-educated workers relatively to low-educated in these local labor markets. For this reason, wage inequalities between education groups decreased less in these markets. Because wage inequalities were lower there at the beginning of the studied period, it leads to a spatial convergence of the local wage inequalities by education up to now. However, should trends remain the same, a spatial divergence could

occur similarly to the US. Future trends depends on how labor supply and demand by education evolve. For supply, it depends mostly on individual education choices, on national and local policies and on internal and external migrations. Future trends of labor demand are difficult to predict but understanding its actual determinants or the ones of similar economies is helpful.

The fourth chapter shows that Information and Communication Technology had an impact on the demand for high-skilled workers relatively to low-skilled workers. The assumption that computer increases the demand for workers performing abstracts tasks and decreases the demand for workers performing routine tasks is verified. It also shows that low-skilled workers switch from jobs with routine tasks to in-person service jobs but also to unemployment, in particular low-skilled workers that were performing routine tasks of support such as clerical work. This might be due to the fact that the demand for in-person service jobs did not increase in the major agglomerations where clerical jobs disappeared, but in rural and touristic areas. This chapter also shows very different patterns for production and support occupations, which are consistent with the functional specialization tested with a very different approach in the second chapter.

# Part I

# Determinants of the location of jobs and workers within and between local labor markets : evidence from two French public policies

# Chapter 1

# Do enterprise zones help residents ? Evidence from France

# Introduction

Enterprise zone programs (hereafter EZ) were launched in the 1970s in the UK as a remedy for deprived urban neighborhoods. Numerous programs have been implemented subsequently: in the US since the 1980s and in France since the 1990s. They are based on more or less generous tax exemptions granted to firms located in chosen areas. They generally target labor and/or capital expenditures. EZ programs are still quite popular (report on enterprise zones, 2013), in particular among local politics, but they are costly and the urban problems they were meant to solve are still pervasive decades later. In France for instance, in August 2012, outbreaks of violence occurred in poor urban neighborhoods. More generally, the unemployment rate is still much higher in these zones (24% in 2010 against 9.5% for the whole country, ONZUS (2011)). An evaluation of these programs is therefore important from a public policy point of view. But Neumark and Simpson (2014), Lynch and Zax (2011) and Ham et al. (2011) reviewed the evidence on EZ, and found it difficult to arrive at a general statement about their efficiency, although studies are quite numerous. EZ can in fact be evaluated on various dimensions as they affect equilibria on both the labor and housing markets. Labor market outcomes from the firm or the worker point of view, land prices and displacement effects are therefore all relevant outcomes. For the French case, there are substantial evidence on firm outcomes and mixed evidence on land prices. This paper provides new results on the effect of French EZ on the labor market outcomes of those who reside in these zones. And it also provides results on displacement and social composition effects that have not been much studied (some exceptions on US enterprise zones are Freedman (2013) and Reynolds and Rohlin (2015)) but are quite crucial for understanding the mechanism of EZ.

As pointed out by Neumark and Simpson (2014), EZ are specific among place-based policies because their ultimate goal is to help people and not places. There is a redistributive aspect to these programs since EZ are targeted at depressed areas (low income, high poverty rate, high unemployment rate). The program implicitly assumes that bringing jobs closer to residents is a solution to their deprived situation. The idea that too great a distance between jobs and residency prevents some people from finding a job is known as the spatial mismatch hypothesis (Gobillon et al. (2007)) and the purpose of EZ programs is to reduce spatial mismatch. But bringing jobs into the zones might not be enough : the financial incentive may be enough to make firms move into the area, but will they necessarily employ those living nearby? In particular, if the skills of residents do not correspond to the needs of the firm? In other words, spatial mismatch might not be the only reason for the difficulties experienced by the residents on the labor market; other factors such as skills mismatch or discrimination could be responsible too. In that case and if the cost of commuting to the zone is not too high, firms would keep on employing people from

outside the zone. Briant et al. (2015) have indeed shown that the less isolated EZ attract more firms : this is an important clue that the commuting possibilities may play a part in the success of EZ. [1]

To counteract this mechanism, some programs have a local hiring condition : exemptions are granted only if a percentage of the workforce resides in the zone. The addition of this condition is also an indirect indication that bringing firms into the zone is not enough, and thus that spatial mismatch alone cannot account for the poor performance of residents on the labor market. The presence of this condition may hinder firms from hiring outside the zone, but it may then raise the incentives for workers with profiles different from those of the EZ to move into the EZ. In fact, even without a local hiring condition, there is an incentive for workers who can potentially work for the EZ firms to move into the zone, as they thus become cheaper hires for the EZ firms. Gottlieb and Glaeser (2008) summarized this concern this way "place-based policies that throw enough resources at a small community may indeed be able to improve the quality of that place, but it is not obvious that the poorer residents of that community will benefit. Some community-based policies may just lead employers to come to the area and hire new migrants." The next step in evaluation is therefore to try and find out whether workers did indeed change their residency because of the program, or to put it differently, whether the social composition of the zones changed.

Lastly, if there is an effect of EZ on the location of firms and/or residents, we would expect an effect on land/real estate prices, as demand for space increases and its supply is quite inelastic. Some papers even argue that in the long run all the subsidies will be taken into account in land/real estate prices and will thus benefit land owners (Lynch and Zax, 2011, Gottlieb and Glaeser, 2008, Kline and Moretti, 2014). So, when examining the impact of EZ on targeted zones, general equilibrium effects should be taken into account, in particular, in the long run. Another issue, related to general equilibrium effects across space, is the possibility of positive or negative externalities on adjacent zones. The gains of the treated zones might be obtained at the expense of their neighbors.

The French enterprise zone program was implemented in 1997, then renewed and extended in 2004 and 2006. It grants very large tax exemptions to firms located in the enterprise zones and it has a local hiring condition : the payroll exemptions are granted only if at least 20% of the workers are residents of the enterprise zone, 33% after 2002. Most econometric evaluations of French EZ used establishment level data and are thus concentrated on firm outcomes. Rathelot and Sillard (2008), Givord et al. (2013), Mayer et al. (2013), Trevien et al. (2012) and Briant et al. (2015) all studied business creations and/or firm employment located in the zones.

[1] The firms might also be motivated by the ease of reaching suppliers or customers.

They found a small positive effect of the EZ on these outcomes for the 2004 program, and a stronger effect for the one of 1997 (about 50 000 jobs after 5 years for 38 zones, (Trevien et al., 2012)). Gobillon et al. (2012) partly address the issue of the impact on residents by studying the unemployment exit rate of the EZ residents, controlling by their characteristics. But they provided results for the Paris region, and at a broader spatial level than the zone itself (since they observed only municipalities containing an EZ). Although they studied the 1997 EZ for which the effect on firms was quite strong, the effect they found is both small and temporary (10 jobs per semester per zone). Because of the local hiring condition, these results may appear contradictory. This analysis complements and reconciles these results by showing that, while there was a significant effect on the employment of residents, it was to some extent driven by an effect on the social composition of the zones. We therefore both extend the results of Gobillon et al. (2012) to the whole territory and provide new evidence on EZ effects on social composition of the targeted areas. The analysis shows that the program impacted not only the location of firms but also the location of the residences of the workers and thus the social composition of the EZ.

More precisely, the unemployment rate of residents of 1997 French EZ has significantly decreased thanks to the program, and this effect strengthened when the local hiring condition tightened. This hints that the higher unemployment rate in the EZ is probably caused more by skills mismatch or discrimination than by spatial mismatch. Second, a significant part of the effect was driven by composition effect, i. e. the unemployment rate of the residents decreased because of an increase in the share of high-educated residents in the zones.

Section 1 presents the French enterprise zone program ; section 2 the evaluation strategy. Results are presented in section 3. In section 4, some robustness checks are performed. Section 5 concludes.

## 1.1 The French program of enterprise zones

This section presents the design of the French EZ program and the characteristics of the targeted zones before the start of the program.

### 1.1.1 The design of the program

The ”Pacte de Relance pour la ville” (Urban Stimulus Package) was enacted in 1996 (effective in 1997). It created 3 types of priority zones, roughly nested. First 751 ZUS (Zones

d'Urbanisation Sensibles, sensitive urban zones) were defined. The choice was inspired by previous urban programs and by qualitative criteria such as "derelict housing stock" and "unbalance between residential and working zones." Second, among these ZUS, 416 ZRU (Zones de Redynamisation Urbaine, urban redynamisation zones) were then defined, and, third, from that set 44[2] ZFU (Zones Franches Urbaines, urban enterprise zones, hereafter designated as ZFU 1G) which were the most disadvantaged according to a synthetic index of deprivation. This index was computed using the unemployment rate, the proportion of residents under 25 years old, the proportion of residents without a diploma of the zones and tax potential of the hosting municipality.[3]. The ZFU program was renewed and extended to 41 new zones in 2003 (effective in January 2004, hereafter designated as ZFU 2G) and 15 in 2006 (effective in 2006, hereafter designated as ZFU 3G) thus creating a second and third generation of ZFU. There are thus today 100 ZFU. The map in figure 1.1 shows that the 3 generations of ZFU are located all over the French territory in major urban areas and that an important share is located in the Paris region.

The ZFU are the French equivalent of US and UK enterprise zones. Firms located in the ZFU can benefit from large tax exemptions (corporate income tax, local business tax, payroll tax) for 5 years. The payroll tax-exemption is fully granted to the portion of wage below 1.4 times the minimum wage and partially up to 2 times the minimum wage. These exemptions are granted to firms with less than 50 employees, and to new firms as well as to firms already in the zone before designation. As a comparison, firms in the ZRU benefit from exemptions for only one year and only when they are new incomers. The ZRU are thus very lightly treated in comparison to the ZFU (see figure 1.18 for a detailed comparison). There are no systematic exemptions for the ZUS.
In 2002, apart from the creation of new ZFU, the program was also renewed for the existing ZFU, and a progressive exit from the program was implemented : instead of a total halt of the exemptions after 5 years, a degressive rate is applied to the exemptions over the following 3 to 9 years. A firm can thus be treated for up to 14 years.

Another key feature of the program is the fact that payroll tax exemptions are made conditional on local hiring : a proportion of at least 20% of employees must be living in the zone for the firm to benefit from payroll tax exemptions. The level of local residency needed to meet this condition was extended to 33% in 2002 and 50% in 2012. In 2002, it was also extended to all

[2]38 without French overseas territories

[3]The tax potential is defined as a theoretical product of local taxes in case the average national rate were applied to the municipality for each of the local rates.

Figure 1.1: Map of French enterprise zones


Source : French Urban policy department

residents of the ZUS who are located within the same urban unit[4] as the ZFU. The residents of a ZUS (or ZRU) who are in the same urban unit as a ZFU can therefore be directly impacted by the program since 2002. Lastly the only jobs eligible for the payroll tax-exemption condition are ones that employ workers on long-term contracts, a category that covers open-ended contracts (CDI, "contrat à durée indéterminée") and fixed-term contracts of more than 12 months.

### 1.1.2 Some descriptive statistics

In this part, we describe the 3 types of zone in 1990 before the start of the program and compares them to the municipalities they belong too (hosting municipalities). We look into some labor market characteristics and some characteristics used explicitly or implicitly in the choice of the zones.

We compare in columns 1 and 2 of table 1.1 all the priority zones of the program to hosting municipalities. The unemployment rate in the priority zones is twice the one of hosting municipalities. Residents are younger with an average age of 31 compared to 37 and a share of residents under 25 of 47% against 41%. They are less graduated with a share of residents without a degree of 57% compared to 50%.

"Derelict housing stock" is mentioned as a criteria in the designation of the zones. No direct measure is available for the quality of housing but since these neighborhoods were famous for large and old social housing, we compute the share of social housing. Indeed it is very important and is an important feature of these zones. In the zones targeted by the program, more than 60% of the population lives in social housing while it is only 15% in the hosting municipalities. We can also measure the average number of persons per room living in a dwelling as a measure of low housing quality and it is higher in the targeted zones than in the hosting municipalities.

The situation of young residents is often pointed out by media or politics as a factor for outbreak of violence in these neighborhoods. Indeed 15-25 year old residents of the priority zones are less in studies or employment. Lastly, segregation issues are often linked to immigration and integration issues in the public debate and these zones are indeed zones with a much higher share of foreign residents with a nationality from outside the European Economic Community.[5]

Columns 3 and 4 of the table 1.1 present the same measures for ZRU and ZFU1G and they are indeed the most deprived among the priority zones. ZFU1G are also much more populated,

[4]Urban units are defined by the INSEE (French national institute of statistics) as a municipality or a group of municipalities forming a continuous built-up zone (no space of more than 200 meters between any two buildings) and with at least 2000 inhabitants.

[5]In 1990, the members are Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom.

approximately 19 000 residents on average compared to roughly 7000 for the other zones, which is due to the fact that having a population over 10 000 was a criteria to become a ZFU.

Table 1.1: Characteristics of the different type of zones in 1990

| | Hosting municipalities (1) | ZUS (2) | ZRU (3) | ZFU1G (4) |
|---|---|---|---|---|
| Average age | 37 | 31 | 31 | 30 |
| Share of under 25 year old | 41% | 47% | 48% | 50% |
| Share of men | 45% | 47% | 47% | 48% |
| Share of no diplomas | 50% | 57% | 58% | 60% |
| Unemployment rate | 9% | 18% | 19% | 20% |
| Unemployment rate of 15-25 year old | 20% | 28% | 30% | 31% |
| Share of 15-25 years old studying | 54% | 48% | 48% | 47% |
| Share of 15-25 years old not in employment nor studying | 14% | 20% | 20% | 21% |
| Share of foreigners from European Economic Community | 2% | 3% | 3% | 3% |
| Share of foreigners from outside EEC | 4% | 15% | 15% | 17% |
| Share of French by naturalization | 3% | 5% | 5% | 5% |
| Share of French by birth | 84% | 74% | 75% | 72% |
| Share of public housing | 15% | 63% | 67% | 68% |
| Number of persons per room of the dwelling | 0.85 | 1.05 | 1.05 | 1.09 |
| Average population size of a zone | | 6717 | 7221 | 19136 |

Source : 1990 Census

1990 European Economic Community definition is used : the members are Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom.

## 1.2 Evaluation strategy

In this part, we review the economic theory related to EZ and describe the data and econometric methodology used in order to evaluate the EZ program.

### 1.2.1 Theoretical background

The goal of EZ programs can be summarized as follows : reducing territorial inequalities through an increase in economic activity and an improvement of the labor market situation of residents of deprived neighborhoods. These programs can be viewed as a “territorial affirmative action”, since they introduce a break in the equality of treatment between territories. In order to evaluate them from a public policy point of view, it is therefore necessary to understand the determinants of the inequalities between neighborhoods, the relevance to correct them from

a welfare perspective and the efficiency of EZ program to achieve this goal. Determinants of inequalities between neighborhoods can be divided into three main sources : exogenous differences such as infrastructure or natural endowments, the effect of "space" or "distance" on the labor and housing markets and social composition effects due to a sorting of residents or firms. The three types of determinants seem relevant for the French case. First, there is a lack of infrastructure in these deprived neighborhoods that could explain productivity differences.[6] Gobillon and Selod (2007) found empirical evidence of the presence of spatial mismatch for the Paris region, and descriptive statistics of the section 1.1.2 show that sorting by skills is also an issue. Economic theory is a useful tool to understand mechanisms at play in EZ programs, since they involve equilibria on the labor and housing markets. But, while there are numerous empirical studies on enterprise zones, theoretical studies are much scarcer. The few theoretical models that explicitly account for EZ programs and their impact on welfare (Busso et al. (2013), Kline and Moretti (2013) and Kline and Moretti (2014)) deal mostly with the first source of the territorial inequalities (exogenous local differences). Urban labor economics theory and the spatial mismatch hypothesis shed light on the second one, while the sorting issue is not much explored in relation with EZ, neither empirically nor theoretically. We present in this section existing models or elements from theory as a guide to the following empirical evaluation.

Busso et al. (2013), Kline and Moretti (2013) and Kline and Moretti (2014) propose models of urban labor markets, give some predictions on the effect of EZ programs and perform welfare analyses. They all model an EZ program with a local hiring condition (as in the French program). In these models, differences between neighborhoods are exogenous since they are linked to some amenities.

More precisely, Kline and Moretti (2014) propose a standard spatial equilibrium model without market imperfections which can be taken as a benchmark. Workers and land owners are separate. Workers supply a unit of labor inelastically and they also rent inelastically a unit of housing. They can choose their location of residence but commuting is not allowed and they have heterogeneous preferences for some local amenities. Productivity of the production sector depends on local amenities. In this framework, EZ exemptions increase the demand for workers in the EZ and the new labor market equilibrium depends on how the supply of workers reacts. The key parameters are therefore the mobility of workers (depending on the heterogeneity of their taste for neighborhoods) and the elasticity of the housing supply (assumed to be exogenous and depending on local characteristics). A result of Kline and Moretti (2014) analysis is that the only case where there could be a welfare benefit is when workers are not mobile. In that case, no jobs are created in the EZ and EZ credits translate into an increase in the EZ local wages since

[6]Note however that it could be considered as exogenous only in the short term.

EZ labor demand increases and the labor supply is stable. In that case, since EZ exemptions are funded by the whole economy, the program is equivalent to a redistributive policy from rich to poor neighborhoods. On the contrary, if workers are sufficiently mobile and the housing supply is not much elastic, EZ implementation leads to an increase in the number of workers and in land rental rates in EZ neighborhoods and in a welfare loss as land owners ultimately benefit from the program.

Busso et al. (2013) model is very similar (there are no market imperfections and differences between zones are exogenous) but they allow workers to live and work in different places and they introduce a commuting cost. Therefore workers can choose both their place of work and residence. In this framework, results for the EZ and welfare analysis are quite similar to the previous model but because of the commuting possibility the wages of workers living outside the EZ and working in the EZ can also be impacted.

If these models, where there are no market imperfections and differences between zones are linked to exogenous local amenities, are a good approximation of reality, we could empirically observe an increase in population and in land prices if workers are mobile and an increase in wages if they are not mobile. However it is not likely that there are no market imperfections and, moreover, they are no unemployment in these models whereas EZ neighborhoods are often chosen because of their high unemployment rate. Kline and Moretti (2013) propose another model, close to Kline and Moretti (2014), but with some market imperfections under the form of hiring costs that allow for unemployment. Note that differences between zones still derive from differences in productivity due to local amenities. In this setting, hiring subsidies in zones where productivity is low might increase their employment. In that case, EZ programs can be seen as correcting market imperfections and might increase welfare, even with mobile workers.

In this type of models, there is an exogenous difference between the zones and EZ programs try to correct it in an efficient way. But some specifically "spatial" mechanism might also be responsible for the spatial inequalities within cities. Urban labor economics dealing with job search frictions within urban labor markets and specifically with the issue of spatial mismatch, can also shed another light on EZ programs. Spatial mismatch can be viewed as a market imperfection but, contrary to the hiring cost in Kline and Moretti (2013), it is not uniform across zones. Therefore no exogenous local differences are needed in this range of theoretical models to obtain territorial inequalities at equilibrium. If EZ programs contribute to the reduction of this "imperfection", they may be able to increase welfare.

More precisely, urban labor markets theory models such as presented in Zenou (2009) assess where employed and unemployed workers are located within cities at equilibrium. More complex models also give results on wages. The central parameters in this literature are the elasticity of housing supply, the commuting cost of workers, the relocation cost for workers (and firms)

and the job search cost. There are in most models no specific differences between zones and no heterogeneity between workers. The sorting of employed and unemployed workers arises purely from the spatial equilibrium of the housing and labor markets. In this conceptual framework, the fact that workers of segregated areas experience poor labor market situations because of their distance to jobs is often related to the concept of spatial mismatch. Gobillon et al. (2012) review in detail different mechanisms of spatial mismatch. Spatial mismatch can be related to commuting cost and housing market discrimination. Some workers might be discriminated on the housing market and if they live far from jobs and if commuting costs are too high, they remain unemployed. Another possible mechanism is that job search cost increases with distance, producing some inefficiencies. On the firm side, employers might discriminate workers from segregated areas because of prejudice or be reluctant to hire workers with long commute as it may lower their productivity.
In this framework, EZ can be thought as a way to reduce spatial mismatch. Since, to our knowledge, there is no theoretical model assessing the impact of EZ on spatial mismatch, it is difficult to predict the general equilibrium and welfare effects but EZ should decrease spatial mismatch and thus improve the EZ workers situation, maybe to the expense of other neighborhoods. As in the previous models, EZ impacts probably depend on the mobility of workers and on the elasticity of the housing supply. A major difference with the previous models is that differences between zones are only the consequences of the distance to jobs and not of a lower productivity in the zone. The local hiring condition should, in principle, not be necessary to improve the situation of the residents as it should be be more interesting for a firm to employ a local resident rather that one that commutes. An exception might be when spatial mismatch is due to discrimination against workers from segregated areas. In that case, a local hiring condition might be necessary to overcome prejudice, at least in the short term. Many EZ programs have a local hiring condition which means that policy-makers do not believe distance between jobs and workers to be the only mechanism to explain the deprived situation of these neighborhoods.

Last, one major issue is the sorting of workers into neighborhoods. In previous models, workers are homogeneous in skills but, in practice, workers from EZ neighborhoods are less skilled and this might already explain an important part of the spatial differences. Indeed in economic geography, sorting by skills explain an important part of spatial differences in wages between labor markets (Combes et al. (2008)). Although equilibria are different within labor markets because of the possibility to commute, sorting by skills could also be a major issue. The effect of EZ in the case where differences is due to sorting by skills has not been modelized to our knowledge. This might be due to the fact that in that case, EZ programs do not seem to be a good instrument to correct inequalities between zones. It could be more efficient to improve the

skills of local workers through education policies. Nonetheless in an empirical investigation, this issue has to be taken into account.

From this selected review of EZ theoretical background, it appears that housing market outcomes and displacement of workers are as much an issue as labor market outcomes when evaluating EZ programs. To give elements on general equilibrium and welfare effects, the situation of deprived neighborhoods should be analyzed in relation with the situation of neighboring areas; the displacement of workers and firms and the housing prices should also be studied. Testing the effect of the local hiring condition is also relevant as its effectiveness might give hints on the underlying determinants of the deprived situation of the zones, especially regarding spatial mismatch versus skill mismatch. Last evaluating short and long term effects seem highly relevant as housing supply and mobility of workers effects are key and probably not immediate.

### 1.2.2 Data

As suggested by theory, we need to look at various dimensions to assess EZ programs. Previous studies on the French case have already shown that a significant number of jobs were created by firms in the ZFU first generation (Trevien et al. (2012)) and second generation (Rathelot and Sillard (2008)). The purpose of this evaluation is therefore to study the effects of the EZ program on the residents of the zones. It is necessary to use data that includes information on the location of the residences of the workers. The French Labor Force Survey is a survey conducted at the main residence of households, and gathers fine geographical information (at the census block level, finer than municipality). All household members aged 15 and over are interviewed. The survey generates rotating panel data (dwellings are interviewed several times) and the sample is stratified and clustered. Areas of 40 dwellings (or 20 in cities of more than 100 000 inhabitants) are sampled, and all the dwellings in each area are surveyed.

From 1993 to 2002, surveys were annual and conducted in March. Each dwelling was interrogated thrice. A third of the sample was renewed each year. The sample rate was 1/300 and there were thus approximately 75 000 dwellings per year. Since 2003, surveys have been conducted every quarter. Each dwelling is interrogated 6 times and a sixth of the sample is renewed each quarter. The sample rate has been raised to 1/600 and there are approximately 36 000 dwellings per quarter. Note that the unit of observations is the dwelling , hence when people move in or out a dwelling, they also enter or exit the sample. The weights provided by the producer (INSEE) are used for statistics and estimations.

This data set is of particular interest for this evaluation, as the geographical level is sufficiently fine to identify the targeted zones, and it provides a great deal of information on the labor market

situation of residents. The available geographical information allows to know if a dwelling is located in a ZUS or in a one of the 3 generations of ZFU but the information about the ZRU is available only in the data prior to 2002. A proxy for ZRU status is thus used which is the fact of being a ZUS but not a ZFU and being located in a municipality containing a ZRU. Table 1.19 in appendix compares these 'approximated 'ZRU and the actual ones in the 1990 Census on various dimensions such as gender, age, share of people without diplomas, unemployment and they are indeed almost identical.

Last, a comparison of the sample of ZUS and ZFU of the first generation (ZFU1G) in the 1999 LFS to the 1999 Census confirms that the LFS sample is representative along various dimensions (see table 1.20 in appendix).

### 1.2.3 Outcomes of interest

Our first variable of interest is the EZ residents unemployment rate as this is a major labor market outcome and reducing it is one of the main objectives of the program. In theoretical models, when unemployment is not taken into account, effects for residents translate through wages. In the empirical implementation, using wages raise selection issues as wages are observed only for employed workers but we present nonetheless some evidence as a complement to our main results on unemployment. We also present results on the share of long-term contracts as exemptions are conditioned on them. Since theory states that if commuting is possible, firms might employ residents from outside the zones, it is also useful to estimate the effect of the program on the unemployment rate of both EZ residents and of non-residents within commuting distance of an EZ. For the latter, we use people living in a municipality hosting an EZ but not in the EZ itself. This way, we can reasonably assume they can commute to the EZ.

In our empirical implementation, a major issue is to deal with the fact that workers are not homogeneous as assumed by the existing theoretical model on EZ programs. A possibility is to control for relevant observable characteristics. In that case, we are evaluating the effect of the program controlling for composition effects. If the EZ program had no effect on the social composition of the zones, it should not alter our estimates but mostly increase our precision. But, if workers are sufficiently mobile, displacement is a major issue. Comparing results with and without controls is therefore a first empirical way to assess the potential importance of displacement effects. We use as control variables : gender, age, age squared, level of education, nationality. For education, residents who finished their studies are split in 3 groups : low degrees (up to junior high-school), medium degrees (low vocational and high-school degrees) and high

degrees (college and university degrees). For nationality, the share of residents with a nationality from outside the members of the European Economic Community is computed.[7]

In theoretical models, since workers are homogeneous, displacement effects translates into an increase in population size and housing rental rates. Unfortunately, housing rental rates are not available in our data set and the small size of our sample does not allow to estimate population size level. And, in our case, workers are heterogeneous. We therefore anticipate that EZ might not only attract more workers but also workers with different skills who might compete with the "original" residents on the housing and labor markets. As they are not completely substitute and do no occupy the same type of jobs, effects also depend on the type of jobs offered by firms. Building a theoretical model taking into account the heterogeneity of skills is beyond the scope of this paper but we can assess its empirical relevance. In addition to the comparison of estimations with and without controls, we therefore directly estimate the effect of EZ on the social composition of the zones. We use as outcomes of interest two major individual determinants of labor market outcomes : education and age as a proxy for experience. This is a second empirical way to assess the importance of the displacement of workers, a major concern for EZ programs since it has welfare implications.

To further examine this question, we wish to distinguish, within the zone, the arriving, staying and leaving residents. This information is not available, but thanks to the survey design, it is possible to know if the residents were living in the same dwelling as the year before. A new resident is therefore defined as someone who did not live in the same dwelling the year before. This is only a proxy of what it would be useful to measure, as they might have arrived from another dwelling in the same zone. However it is possible to know if they came from another municipality; so they are split between the ones coming from within and from outside the municipality. We can therefore study the share of new residents in the EZ and if their observed characteristics changed because of the EZ programs.

Last, another way to shed light on the skill mismatch issue, is to look at the labor demand side and study the qualification of the jobs occupied by residents. In the analysis, we separate the occupations of residents working in the private sector into three groups based on the French classification of occupations: high-skilled (executive jobs), medium-skilled (for example, mid-level manager), low-skilled (employees and workers). Due to the number of observations, it is the most detailed information we can use.

[7]More precisely, here the members of EEC in 1999 are used,except Finland that could not be isolated in the data : Austria, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

### 1.2.4 Econometric strategy

The empirical strategy is based on a standard Difference-in-Difference method (hereafter DD), implemented on the treated group (ZFU residents) and a control group that is described in the next section. As the sample is clustered, it is very likely that errors for individuals of the same area are correlated. To take into account the potential spatial correlations, data is aggregated at the sampling area level as suggested by Bertrand et al. (2004). To deal with the serial correlation problem due to the rotating panel pattern and take into account potential heteroscedasticity, we can allow for a correlation between the errors of each sampling area and compute a White style robust covariance matrix.[8] In that case, the estimation of the variance of the estimator does not require the number of observations of a sampling area to be the same. Here, this is important as some sampling areas at the beginning and end of the period are observed only once or twice (due to the sample design).

The model is then the following, with $i$ indexing a sampling area, $t$ the year (or year $\times$ quarter after 2002), N the total number of sampling areas and $I_N$ the identity matrix. $Y$ is the outcome of interest (for instance the unemployment), $ZFU$ is a dummy for being in a treated zone, $\gamma_t$ is a year (or year $\times$ quarter after 2002) fixed effect, $\lambda_{uu}$ a urban unit fixed effect :

$$Y_{it} = \alpha ZFU_i + \beta ZFU_i * 1_{t \geq 97} + \gamma_t + \lambda_{uu} + u_{it}$$

with

$$\widehat{Var}(\widehat{\beta}) = \frac{(\sum_{i=1}^{N} \underline{\widehat{x_i}}' \underline{\widehat{x_i}})^{-1} (\sum_{i=1}^{N} \underline{\widehat{x_i}}' \underline{\widehat{u_i}} . \underline{\widehat{u_i}}' \underline{\widehat{x_i}}) (\sum_{i=1}^{N} \underline{\widehat{x_i}}' \underline{\widehat{x_i}})^{-1}}{N}$$

The $\beta$ coefficient in the linear regression gives the effect of the program under the hypothesis that the difference between treated and control would have been constant over time in the absence of treatment. The urban unit fixed effect allows to control for local specificities. Note that in the case where there is only one type of zone (treated or control) in each urban unit, the pre-treatment control $ZFU_i$ is redundant.

Regressions are estimated on the period 1993-2007.[9] This means that the effect is estimated

[8] see Wooldridge (2009) for more details.

[9] Estimations on the period 1993-2011 have been performed and the results are similar. The 1993-2007 period

up to 10 years out from the start of the program. The sample is restricted to the 15-65 year old residents as the interest is mostly in labor market outcomes.

### 1.2.5 Choice of the control group

The validity of the estimation strategy strongly relies on the choice of a control group. This section presents various possible choices.

Since the ZFU have been chosen from among the ZRU, which are very specific urban neighborhoods, it makes sense to try to find a control group among the remaining ZRU, which are more similar to them than other zones as seen in the descriptive statistics. The ZFU have been chosen from among them as those most deprived by some social indicators (the synthetic index mentioned earlier). By nature they were distinguished by a different level of deprivation, but since all ZRU are zones of deprivation, we can also assume (and partly test) that their evolutions were similar before designation and would have remained similar without the program. The estimated effect is thus the effect of becoming ZFU compared to ZRU. Only the first generation of ZFU is evaluated here. There are too few observations of 3rd generation zones in the sample and the placebo tests rejected control groups among the ZRU for the 2nd generation. There are several ways to construct a control group from among the set of ZRU :

- First simply take all ZRU.
- ZRU which are too close geographically to the ZFU might be affected by the treatment. A second approach excluding the ZRU that are in the same urban unit of a ZFU is thus tested.
- Third, since there have been several waves of the program, the zones that became ZFU later (in 2004 and/or 2006) could be used as a control group for the first generation. We may assume that the ZFU of the subsequent generations will have common features with those of the first generation. This is a standard strategy in the evaluation literature.
- Lastly, a very common approach in the literature is to use a propensity score matching method : we estimate the probability of being treated according to some characteristics. Each zone is assigned a score according to this model, and each treated zone is matched to the non-treated zone with the closest score (closest neighbor method). We test this

is preferred as it excludes the 2008 crisis and also reduces the difference in number of years before and after treatment.

strategy using information about the zones from the census of 1990 (population size, share of 15-25 year olds, unemployment rate, share of public housing) to find a match for the ZFU1G among the ZRU that are not located in the same urban unit (see table 1.21).

In any case, observations of the ZRU which became ZFU later (2G or 3G) are excluded after they turned into a ZFU (in 2004 and 2006). Moreover, because of the extension in 2002 of the local hiring condition to all residents of the ZUS falling within the same urban unit as a ZFU, the observations of ZRU in the same urban unit as a ZFU are excluded, but only after 2002 and after the ZFU is created. As these cases are not too numerous, it is simpler and not too costly to exclude them rather than keeping them and controlling for all these events.

We run placebo tests on the different control groups (see section 1.4.1) for various outcomes and ZRU that are not in the same urban unit of a ZFU is the preferred control group. Although our placebo tests show that treated and control group have similar trends before the treatment, we still have to assume the trend would have remained similar without the program. It could be argued that ZFU have been selected because of their expected reaction to treatment or because of their expected economic trend. One limit of our strategy is that it does not control for this potential dynamic selection. Since ZFU were chosen among ZRU with a synthetic index, in principle, we could implement a Regression Discontinuity Design (RDD) estimation comparing ZRU and the ZFU with close values of the index and argue that the fact to be just under or above the threshold is exogenous. This could allow to get rid of the dynamic selection issue. Unfortunately, the rule was not strictly applied and no clear information is available on other considerations that might have entered in the process of ZFU designation. A fuzzy RDD strategy might be possible but we do not have enough observations to implement this strategy. We therefore prefer to rely on a DD strategy rather than a RDD strategy to estimate the effects of the French ZFU program and assume that the trends of the control and treated groups would have remained parallel if the program had not been implemented.

Our main outcomes of interest are computed for ZFU but we are also interested by the ZFU effect on neighboring areas. Hence, we also apply the DD strategy to the zones belonging to the municipality of a ZFU and we therefore need to choose a control group for them. We propose to use the zones belonging to a municipality of the ZFU control group. We run placebo tests to confirm the validity of this strategy.[10]

[10]Results are not presented but available upon request.

## 1.3 Results

### 1.3.1 Results on EZ unemployment rate and wages

This section presents the estimations of the effect of the program on residents' unemployment and wages and compares the result to previous studies.

The DD estimation shows a significant reduction – 11 percentage points – of unemployment in the ZFU1G (column 1 in table 1.2) when its level is roughly 30% just before the start of the program. As the only previous study (Gobillon et al., 2012) evaluating the effect on residents focused exclusively on the Paris region and found a small significant effect, a regression is estimated without the Paris region to check if this region is driving the results. The effect is very close – 9.5 percentage points (column 3 in table 1.2) – and still significant, so results are not driven only by the Paris region.

The effect of the program is also significant with control variables but smaller (column 2 and 4 in table 1.2). Although the coefficients are not significantly different (but it may be due to a lack of power in the estimations), this hints that some composition effects might be at play. This is investigated further in the next section.

Table 1.2: DD estimations for unemployment

| | Unemployment rate | | | |
|---|---|---|---|---|
| | (a) All areas | | (b) Without Paris region | |
| | (1) | (2) | (3) | (4) |
| ZFU1G × post97 | $-0.110^{***}$ | $-0.059^{***}$ | $-0.095^{***}$ | $-0.057^{**}$ |
| | (0.029) | (0.022) | (0.031) | (0.025) |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |
| obs. (sampling areas × year) | 2669 | 2669 | 2481 | 2481 |
| $R^2$ | 0.312 | 0.462 | 0.319 | 0.455 |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

The theoretical models presented previously give results either in term of unemployment or wages. For wages, note that there is a selection issue here. If the new jobs due to the program

have lower wages, the effect on wages will be negative although the wages of jobs not due to the program might have increased. So the results must not be interpreted at an individual level but as a description of the jobs occupied by residents. We use the log hourly wage in the private sector and perform the same estimation than previously : there is an effect of the program on wages (column (1) in table 1.3) but only slightly significant and it is not significant anymore when excluding the Paris region (column (3)) or when adding control variables (columns (2) and (4)). Results on the effect of the ZFU program on wages are for now not very conclusive.

Table 1.3: DD estimations for wages

| | Log of private sector hourly wage | | | |
|---|---|---|---|---|
| | (a) All areas | | (b) Without Paris region | |
| | (1) | (2) | (3) | (4) |
| ZFU1G × post97 | 0.128* | 0.040 | 0.106 | 0.033 |
| | (0.067) | (0.039) | (0.072) | (0.043) |
| obs. (sampling areas × year) | 1270 | 1270 | 1186 | 1186 |
| $R^2$ | 0.41 | 0.625 | 0.42 | 0.622 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

According to theory, EZ has an affect on unemployment or wages if workers are not fully mobile and/or if housing supply is quite inelastic. From the first results, we can conclude that this is the case for the French EZ. It is quite plausible as there is a lot of social housing in these areas which could explain both a low elasticity of housing supply and that workers are not mobile. Indeed, since it is very difficult to get social housing in France, residents have strong incentives not to move once they got one. Nonetheless, since the effect decreases when some controls are added, some composition effects might have occurred, which implies some mobility. Since, in the long run, mobility might be higher and housing supply more elastic and since we estimate the effect of the program over a 10-year period, we next estimate whether there is a time trend in the effect.

For unemployment, there is no significant time trend in the effect of the EZ program , whereas for wages, a significant upward trend is estimated (table 1.4). Once more, as there is a selection issue, results on wages have to be taken cautiously but, for now, this would mean that the effect of program on the unemployment probability was stable during all the program whereas the effect on wages was progressive. It suggests that workers are not very mobile and that first local unemployed people are hired and then, as the labor demand keeps increasing and there is no

Table 1.4: DD estimations for unemployment and wage, test of a time trend for the effect

| | Unemployment rate | | Log of private sector hourly wage | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| ZFU1G × post1997 | $-0.085^{**}$ | $-0.069^{**}$ | 0.018 | $-0.048$ |
| | (0.043) | (0.035) | (0.086) | (0.049) |
| ZFU1G × post97 ×t | $-0.004$ | 0.002 | $0.019^{*}$ | $0.017^{**}$ |
| | (0.006) | (0.005) | (0.011) | (0.007) |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |
| obs. (sampling areas × year) | 2669 | 2669 | 1270 | 1270 |
| $R^2$ | 0.312 | 0.462 | 0.415 | 0.628 |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

more "employable" workers, local wages increase. This means that EZ effect translates into wages when the labor supply is not elastic and is therefore consistent with Briant et al. (2015) who found that firms created more jobs in spatially integrated EZ neighborhoods whereas the impact of the program on local wages was only visible in the more isolated ones.

### Local hiring condition

The first results seem consistent with a rather low mobility of workers. As stated previously, this low mobility might be related to the housing market. Residents might be "trapped" in these neighborhoods because of housing market equilibria. This is one of the mechanism of the spatial mismatch hypothesis. In that case, the local hiring condition should not be necessary. If the deprived situation of the residents on the labor market is due to distance to jobs, bringing jobs closer to them should be enough to improve their situation. Therefore testing the effect of the local hiring condition is a way to assess the importance of spatial mismatch in these neighborhoods. A first way to do it is to use the change in the percentage of local hiring required over the period of study and a second way is to study jobs with long term contracts as it is also part of the requirement.

The local hiring condition was tightened in 2001 (effective in 2002) : it was raised from 20% to 33% and was extended to workers residing in all ZUS that were part of the same urban unit as a ZFU. Column 1 in table 1.5 reproduces the previous estimations adding a dummy for an additional specific effect after 2002. The effect on the unemployment rate is indeed

Table 1.5: DD estimations for unemployment and wages, test of a local hiring condition effect

| | Unemployment rate | | Log of private sector hourly wage | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| ZFU1G × post1997 | $-0.055^{**}$ | $-0.052^{**}$ | $-0.020$ | $-0.024$ |
| | (0.028) | (0.022) | (0.072) | (0.041) |
| ZFU1G × post2002 | $-0.076^{**}$ | $-0.011$ | $0.206^{***}$ | $0.104^{**}$ |
| | (0.030) | (0.024) | (0.071) | (0.043) |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |
| obs. (sampling areas × year) | 2669 | 2669 | 1270 | 1270 |
| $R^2$ | 0.314 | 0.462 | 0.416 | 0.627 |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

stronger by 7.6 point of percentage since 2002. So the tightening of the local hiring condition does appear to have had an effect. What is also striking is that when adding control variables (column 2 in the table 1.5), there is no significant effect of the local hiring condition anymore. It means that the additional effect on unemployment induced by the tightening of the local hiring condition was mostly due to composition effects.[11] In other words, during the first years of the program, "original" residents got more jobs but with the tightening of the local hiring condition, some change in the social composition of the zones occurred and the further decrease in unemployment was due to an improvement of the composition of the zones in characteristics relevant for unemployment status rather than an increase in the probability of finding a job for the residents that would have lived there in the absence of the program.

For wages, when taking into account the tightening of the local hiring condition, a significant positive effect of the program after 2002, with and without controls (20% and 10% respectively), appears.Note that there is an initial negative effect on wages, which, although not significant, might be due to some selection effect. At the start of the program, the selection effect may be stronger with lower-wage jobs created and occupied by residents but after 2002, higher-wage jobs are occupied by residents.

One of the requirements of the local hiring condition pertains to the type of labor contract. Hence another way to test the effect of the program is to study its effect on jobs with a long term

[11]Note that 2002 is also the start of the progressive exit of the program of the firms that were present or created in 1997, so this effect might be interpreted cautiously.

Table 1.6: DD estimations for long term contracts

| | Share among 26-65 years old of private sector workers with long term contracts | | | |
|---|---|---|---|---|
| ZFU1G × post97 | 0.060** | 0.059** | 0.033 | 0.042* |
| | (0.027) | (0.025) | (0.024) | (0.022) |
| ZFU1G × post2002 | | | 0.037 | 0.023 |
| | | | (0.028) | (0.026) |
| obs. (sampling areas × year) | 2702 | 2702 | 2702 | 2702 |
| $R^2$ | 0.257 | 0.374 | 0.258 | 0.374 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

Long term contracts : undetermined duration (CDI) or at least than 12 months. Short term contracts : duration inferior to 12 months.

contract. There is indeed a significant positive effect of 6% of the program on private sector long term contracts share among the 26-65 year old residents (see table in figure 1.6).

When studying the effect of the tightening of the local hiring condition in 2002, estimations on long term contracts lack power but using controls, the effects are stronger and significant before 2002 which seems consistent with the idea that the program had an effect for the "original" residents mostly in the first years.

These set of results show that the local hiring condition has had an effect which means that, without it, resident might have got less jobs or with less favorable contracts and so that spatial mismatch was not the only cause of the high unemployment of these zones. Moreover, it also shows that when the local hiring condition was strengthened, it did not benefit the "original" residents so its efficiency to improve their situation was limited. Is it plausible that it could help only the workers who were the most employable but it was not sufficient for workers with a very low level of "employability".

**Sensitivity to the employment measure**

The unemployment rate is one way to look at the effect of the program, but it depends on both the number of jobs occupied by residents[12] and their rate of participation in the labor force. So we might want to look as well at the employment rate of residents. Moreover, for the 15-25 year olds the participation in the labor force is closely related to the completion of studies, unemployment rate is not a good measure for this age group. A more relevant way to look at

[12]Note that it is not possible to determine whether the jobs are indeed located in the ZFU, but there is no reason why job opportunities outside the zones would evolve differently between treated and control groups.

this age interval is therefore to look at the share who is nor in employment nor studies. The sample is therefore split at 25 years old and for the 26-65 year olds, we estimate the effect on both the unemployment and employment rate.

Table 1.7: DD estimations for labor market outcomes : sensitivity analysis

| | | | | |
|---|---|---|---|---|
| | 26-65 year old unemployment rate | | | |
| ZFU1G × post97 | $-0.109^{***}$ | $-0.069^{***}$ | $-0.054^{*}$ | $-0.054^{**}$ |
| | (0.028) | (0.024) | (0.028) | (0.023) |
| ZFU1G × post2002 | | | $-0.077^{***}$ | $-0.022$ |
| | | | (0.029) | (0.025) |
| obs. (sampling areas × year) | 2655 | 2655 | 2655 | 2655 |
| $R^2$ | 0.268 | 0.395 | 0.270 | 0.395 |
| | 26-65 year old employment rate | | | |
| ZFU1G × post97 | $0.108^{***}$ | $0.077^{***}$ | $0.035$ | $0.050^{**}$ |
| | (0.031) | (0.022) | (0.025) | (0.021) |
| ZFU1G × post2002 | | | $0.046$ | $0.038$ |
| | | | (0.029) | (0.025) |
| obs. (sampling areas × year) | 2702 | 2702 | 2702 | 2702 |
| $R^2$ | 0.293 | 0.527 | 0.239 | 0.527 |
| | Share of 15-25 year olds not in employment nor studies | | | |
| ZFU1G × post97 | $-0.055$ | $-0.003$ | $-0.020$ | $-0.015$ |
| | (0.034) | (0.021) | (0.031) | (0.022) |
| ZFU1G × post2002 | | | $-0.051$ | $0.019$ |
| | | | (0.036) | (0.023) |
| obs. (sampling areas × year) | 2452 | 2452 | 2452 | 2452 |
| $R^2$ | 0.274 | 0.557 | 0.275 | 0.557 |
| | Share among 26-65 years old of private sector workers | | | |
| ZFU1G × post97 | $0.069^{**}$ | $0.063^{**}$ | $0.035$ | $0.045^{*}$ |
| | (0.027) | (0.025) | (0.025) | (0.023) |
| ZFU1G × post2002 | | | $0.046$ | $0.026$ |
| | | | (0.029) | (0.026) |
| obs. (sampling areas × year) | 2702 | 2702 | 2702 | 2702 |
| $R^2$ | 0.238 | 0.378 | 0.239 | 0.379 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

The effect on the unemployment rate of the 26-65 year old residents is significant and of a magnitude of approximately 11% without controls and 7% with controls (see table 1.7). The result for their employment rate are similar. The results for the effect of the local hiring condition on unemployment are also the same as for the 15-65 year olds. For the 15-25 year old residents, there is no significant effect of the program. So it appears that the "youth" situation on the labor market has not been improved by the program.

Moreover, another concern is this: at the same period some public jobs were massively created for young people ("emplois jeunes") and especially young people from these neighbor-

hoods.[13] The "emplois jeunes" program is the same across all ZFU and ZRU but it will be reassuring that the effect of the EZ program examined in this paper is not driven by public jobs of the 15-25 year olds. More generally, the program targets private sector firms, so it is interesting to distinguish employment in the private versus the public sector, to check if the effect was on private sector jobs. Although the program could have had an indirect effect on public jobs, as the economic activity and the tax revenue of the municipalities increased. The effect of the ZFU1G on the share of private sector workers among the 26-65 year olds is thus investigated to assess a
direct" effect of the program. It is significant, around 6% (see table 1.7). It is lower than the effect on the 26-65 year old employment rate although not significantly different. When using control variables, estimations are much closer. So the effect of the program occurs mainly in the private sector.

From these results, we conclude that our main results on resident's employment are not too sensitive to the chosen indicator : unemployment, employment or employment in the private sector.

**Magnitudes**

Before assessing further the effects of the program, the size of the effect estimated here can be compared to other results on the first generation of ZFU. First Trevien et al. (2012) estimated that the program induced a creation of 41500 to 56900 jobs (estimates for the year 2001, 5 years after the start of the program). According to an administrative report of 2002[14], there were 72 409 jobs in ZFU in December 2001 and among them 63 325 were exonerated. So it appears that the majority of these jobs were due to the program.

But these jobs were not necessarily occupied by residents : only 25% of them were occupied by residents (ratio available for 1999[15]). If the ratio is assumed identical in 2001, this means that there were roughly 16 000 jobs exonerated and occupied by residents of the ZFU. This is an upper bound of the direct effect[16] of the program for the residents, as there is no evaluation of what portion of these jobs would have existed without the program.

[13]The "emplois jeunes" are specific jobs for people under 26 years old and a portion of the unemployed aged 26-30. They are created in the public or non-profit sectors and the remuneration is partially paid by the State. The program was created in 1997 and ended in 2002. Only contracts already existing were maintained after 2002.

[14]à la Ville (2002)

[15]à la Ville (2002)

[16]This does not, however, take into account potential positive externalities : the program might also have increased the number of non-exonerated jobs available to the residents through an increase in local economic activity for instance.

There are approximately 294 000 people in the labor force in the ZFU1G in the 1999 Census. So the estimated 5.5 percentage points reduction in unemployment up to 2002 (which is the most comparable to that estimation) corresponds to approximately 16 000 jobs : it is very close to that upper bound.[17]. Note however that this estimation takes into account direct and indirect effect of the program as it estimates the effect on the number of jobs occupied by residents, exempted or not. It could thus in theory be higher than the upper bound of the direct effect.

Gobillon et al. (2012) found that the program created 10 jobs per semester per enterprise zone in the Paris region, so $10\times2$ semesters$\times5$ years$\times13$ zones = 1 300 jobs for the Paris region from 1997 to 2001. Applying their estimates to all enterprise zones proportionally to labor force size, this leads to an estimation of roughly 5 000 jobs created in 2001 thanks to the program and benefiting to the residents. Their estimation was made with control variables so it can be compared to the estimated 5.2%, which corresponds to roughly 15 000 jobs.[18] Therefore it can be concluded that there is an effect on residents for the whole program, not just for the Paris region, and that this effect seems of a larger magnitude than estimated by Gobillon et al. (2012).

We also compute a cost per created job and compare it to other programs. In 2001, the exemptions in ZFU amounted to 293 million euros (à la Ville (2001)). In France since 1993, several payroll tax exemptions for low wage jobs have been implemented. We therefore have to take into account that, without the program, jobs could benefit from other exemptions. We can very roughly estimate the net cost to be half of the gross cost (Benatsou (2009)). This gives an estimated yearly net cost of 9 500 euros per job created. It can be compared to the estimation of 31 000 euros per job created by Rathelot and Sillard (2007) for the 2004 ZFU. Bunel et al. (2012) reviewed the various estimations of the gross cost per job created by the French payroll tax exemptions that can be found in the literature and it varies between 10 000 euros and 50 000 euros (to be compared to our estimation of a 19 000 gross cost per job created). Our estimation thus falls within this range. Note however that estimations can vary strongly according to the way they are computed (as shown by the review of Bunel et al. (2012)) and our estimation is merely indicative. Moreover this is far from being enough to perform a cost-benefit analysis or a welfare analysis since, among other things, general equilibrium effects are not taken into account.

[17]However this estimation is not very precise due to the small number of observations : the 95% confidence interval is 120 to 32000 jobs

[18]The 95% confidence interval is 2 700 to 27 800 jobs.

### 1.3.2 Displacement and composition effects

According to our results, the program decreased residents' unemployment, thanks partly to the local hiring condition. Now we investigate the changes in social composition that seem to have occurred. In column 1 of table 1.8, the same DD regression is estimated but on the age (as a proxy for experience) and the level of education of EZ residents which are two major determinants of labor market outcomes such as unemployment or wage. It shows that since 2002, EZ residents are a bit older and more educated than they would have been without the program, so the program induced a change in the resident social composition of the zone and it happens after 2002. This is consistent with the previous result that the decrease in unemployment after 2002 is due to composition effects.

#### New residents

In order to understand how this composition effect on age and education happened, we present some estimations on new residents, split between the ones coming from within and from outside the municipality. First, the proportion of new residents with either definition was not much impacted by the program (table 1.22 in appendix).[19] In a second step we examine whether the characteristics of these new residents changed because of the program (columns 2, 3 and 4 of table 1.8).

There is no effect of the program on the age of new residents, so it seems that the aging of the residents induced by the program is not linked to new residents. It may be that the people leaving the zones are younger or that the ones staying are older. A possible story is that, before the program, the residents, when getting older and achieving a more stable situation on the labor market, tended to leave the zone but with the program and the local hiring condition they stayed more.

Results for education level are different : the new residents coming from the same municipality before 2002 and new residents coming from outside the municipality after 2002 were indeed more educated. So during the first 5 years of the program, people with a high degree living relatively close to the neighborhood and who had better ex ante chances to be hired, decided to move inside the zone. If they were living close by already, the move might not have been too costly. With the tightening of the local hiring condition people with a high degree from further away decided to move inside the zone. This means that when incentives to hire residents increased, it did not increase the probability of getting a job of the residents but it attracted

[19]These results can be related to Freedman (2012) who found, for another type of place-based policies, an increasing effect on residents' turnover.

Table 1.8: DD estimations of composition effects

| | All | New residents | New residents from other municipalities | New residents from the same municipality |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Age | |
| ZFU1G × post97 | 0.733 | 0.435 | −0.592 | 1.375 |
| | (0.672) | (1.033) | (1.650) | (1.101) |
| ZFU1G × post2002 | 1.862** | −1.170 | −1.459 | −1.619 |
| | (0.933) | (1.147) | (1.616) | (1.479) |
| obs. (sampling areas × year) | 2713 | 1387 | 927 | 1080 |
| $R^2$ | 0.36 | 0.22 | 0.31 | 0.25 |
| | | | Share of 15-25 year olds | |
| ZFU1G × post97 | −0.007 | −0.008 | 0.038 | −0.042 |
| | (0.024) | (0.056) | (0.093) | (0.055) |
| ZFU1G × post2002 | −0.029 | −0.015 | −0.095 | 0.074 |
| | (0.028) | (0.055) | (0.087) | (0.064) |
| obs. (sampling areas × year) | 2713 | 1387 | 927 | 1080 |
| $R^2$ | 0.27 | 0.25 | 0.32 | 0.27 |
| | | | Share with a high-degree | |
| ZFU1G × post97 | 0.007 | 0.051 | 0.010 | 0.070* |
| | (0.023) | (0.041) | (0.071) | (0.036) |
| ZFU1G × post2002 | 0.074*** | 0.069 | 0.178** | −0.001 |
| | (0.027) | (0.053) | (0.084) | (0.060) |
| obs. (sampling areas × year) | 2711 | 1342 | 846 | 1052 |
| $R^2$ | 0.27 | 0.22 | 0.26 | 0.25 |
| | | | Share with a medium degree | |
| ZFU1G × post97 | −0.010 | −0.029 | −0.046 | −0.018 |
| | (0.025) | (0.046) | (0.076) | (0.058) |
| ZFU1G × post2002 | 0.013 | 0.003 | −0.010 | 0.016 |
| | (0.030) | (0.049) | (0.090) | (0.062) |
| obs. (sampling areas × year) | 2711 | 1342 | 846 | 1052 |
| $R^2$ | 0.33 | 0.20 | 0.25 | 0.23 |
| | | | Share with a low degree | |
| ZFU1G × post97 | 0.003 | −0.022 | 0.035 | −0.052 |
| | (0.035) | (0.054) | (0.083) | (0.060) |
| ZFU1G × post2002 | −0.086** | −0.072 | −0.168* | −0.015 |
| | (0.043) | (0.062) | (0.094) | (0.073) |
| obs. (sampling areas × year) | 2711 | 1342 | 846 | 1052 |
| $R^2$ | 0.37 | 0.26 | 0.30 | 0.30 |
| | | | Share living in social housing | |
| ZFU1G × post97 | −0.055 | 0.027 | 0.016 | 0.070 |
| | (0.091) | (0.101) | (0.126) | (0.097) |
| ZFU1G × post2002 | −0.196* | −0.235** | −0.247* | −0.264** |
| | (0.101) | (0.109) | (0.131) | (0.120) |
| obs. (sampling areas × year) | 2713 | 1387 | 927 | 1080 |
| $R^2$ | 0.53 | 0.47 | 0.53 | 0.48 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

people with better education and they had more chance to be hired and maybe fitted better firm requirements.

To sum up, the program in the first years seems to have achieved its goal to help the "original" residents but in the long run and with the tightening of the local hiring condition, some social composition effects occurred. Maybe firms that were the most likely to hire local residents were the ones already present or the ones arrived during the first years but in the long term, ZFU1G have hosted firms less interested in the skills available and attracted other workers with better skills. Moreover, since workers do not adapt their residence choices at once, changes in social composition of the zones were probably slow. Hence, in the short term there was an effect for some of the "original" residents but in the long term a new equilibrium arose.

In the exiting theoretical models, there is only one housing market and therefore no social housing market. But the share of social housing is very high and residents of social housing may not be very mobile, we therefore estimate the effect of the program on the share of residents living in social housing (last row in table 1.8). There is a strong negative effect of 20%, which means that a higher share of the residents live in dwellings of the private sector. This is consistent with the idea that mobility is low in the social housing sector and that displacement effects took place more through the private housing sector.

### Job characteristics

In this section, we investigate the skill level of the jobs occupied by the residents, rather than of the residents themselves, in order to assess if the program induced a change in the demand for skills. If the job skill levels of employed people only are studied, there is potentially a selection effect. If more jobs are created but with different skill levels, and at the same time the job skill levels of those who would have been employed without the program change too, it is not possible to disentangle these two effects and results would have to be interpreted relative to the distribution of the job skill levels without the program. To avoid this, it is more straightforward to present the share of a job with a certain skill level among all residents whether they have a job or not. Moreover, we focus on the 26-65 year old residents as the program had no effect for the 15-25 year olds.

Results in table 1.9 show that the additional jobs are medium- or high-skilled and this holds with and without controls. For medium-skilled jobs, there is an additional effect of the local hiring condition but which seems again related to some composition change as it is not anymore significant when adding control variables. For high-skilled jobs, the effect occurs after 2002 and through composition effects. This confirms the idea that the demand for high-skilled jobs

increases after 2002 and is met by attracting high-degree workers. Although this last feature may not be directly linked to the local hiring condition but rather to a progressive adaptation of workers and firms to the program since there is actually a significant time trend in the effect on high-skilled jobs (table 1.23 in appendix).

Table 1.9: DD estimations for job characteristics

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | share among 26-65 years old of private sector high-skilled jobs | | | |
| ZFU1G × post97 | $0.028^{***}$ | $0.013^{*}$ | 0.008 | 0.008 |
| | (0.009) | (0.007) | (0.007) | (0.006) |
| ZFU1G × post2002 | | | $0.028^{***}$ | 0.006 |
| | | | (0.011) | (0.008) |
| obs. (sampling areas × year) | 2702 | 2702 | 2702 | 2702 |
| $R^2$ | 0.219 | 0.451 | 0.221 | 0.451 |
| | share among 26-65 years old of private sector medium-skilled jobs | | | |
| ZFU1G × post97 | $0.041^{***}$ | $0.025^{**}$ | $0.019^{*}$ | $0.018^{*}$ |
| | (0.012) | (0.010) | (0.011) | (0.010) |
| ZFU1G × post2002 | | | $0.031^{*}$ | 0.010 |
| | | | (0.016) | (0.013) |
| obs. (sampling areas × year) | 2702 | 2702 | 2702 | 2702 |
| $R^2$ | 0.199 | 0.343 | 0.201 | 0.344 |
| | share among 26-65 years old of private sector low-skilled jobs | | | |
| ZFU1G × post97 | −0.018 | 0.012 | 0.006 | 0.017 |
| | (0.027) | (0.023) | (0.024) | (0.021) |
| ZFU1G × post2002 | | | −0.034 | −0.006 |
| | | | (0.027) | (0.024) |
| obs. (sampling areas × year) | 2702 | 2702 | 2702 | 2702 |
| $R^2$ | 0.267 | 0.389 | 0.267 | 0.389 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

High-skilled occupations correspond to number 3 in the French socio-economic ranking, for medium-skilled occupations, it is 4, for employees 5 and for workers 6.
Long term contracts : undetermined duration (CDI) or at least than 12 months. Short term contracts : duration inferior to 12 months.

### Geographical externalities

As seen in the theory, if workers are mobile, EZ programs might have an effect outside the program zone. Moreover, workers who can commute in the zone can be affected too. Geographical externalities are therefore an important issue. There could be for example negative spillovers if unemployed residents of the ZFU were employed instead of neighbors living in closer proximity. Then the number of jobs at the ZFU level would be higher but there would

be a negative effect on the near neighbors. To evaluate this issue, column (1) and (2) of table 1.10 presents a DD estimation of the effect of the ZFU program on the neighbors of the zones.[20] No significant effect on the unemployment rate of the neighbors is detected, whether we use or not control variables. There thus might not be externalities on the neighbors or at least not of a significant magnitude. Nonetheless estimations in column (3) and (4) of figure 1.10 show that there was a decrease in the unemployment of EZ neighbors after 2002. This could be due to the fact that their residents commute into the zone. Indeed if commuting cost is not too high, workers who have strong preferences for their neighborhood, might still have benefited from the ZFU program by commuting into the zone. This would be consistent with the results of Briant et al. (2015) who show that the most accessible ZFU are the most successful in terms of jobs creation.

Table 1.10: DD estimations for geographical spillovers

| | Unemployment rate | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Neighbors of a ZFU 1G × post1997 | −0.013 | −0.007 | 0.012 | 0.009 |
| | (0.009) | (0.007) | (0.009) | (0.007) |
| Neighbors of a ZFU 1G × post2002 | | | −0.029*** | −0.018** |
| | | | (0.009) | (0.007) |
| obs. (sampling areas×year) | 18108 | 18108 | 18108 | 18108 |
| $R^2$ | 0.09 | 0.25 | 0.09 | 0.25 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights.

Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

### 1.3.3 Heterogeneity of the effect by education level

A major concern of the program is also the low level of education in these zones and its effect on the situation of the residents, particularly on the labor market. Indeed the level of education of ZFU residents was used to compute the deprivation index. The effect of the program on the unemployment rate of residents by degree level is therefore estimated in table 1.11. It allows to assess if low-educated workers benefited more or less of the program than high-educated workers and therefore give elements on redistributive aspects of the program. Results are stronger for the residents with a low degree, with and without control variables. For the residents with a

[20]Neighbors are defined as those living in a municipality which contains a ZFU without actually living in the ZFU. The control groups are the neighbors of the ZRU; a placebo test has been performed to verify that they are a valid control group.

high degree, results are weaker and not significant. So it seems that the program indeed benefited to the residents with a low level of education. But regarding the effect of the local hiring condition, an interesting pattern shows up : the effect before 2002 is mainly concentrated on the unemployment of low-degree residents while the effect after 2002 is mainly for high-degree residents (with and without controls). This means that firms hired first residents of the zone with low education level but in a second time, residents with a higher level of education. This adds up with the composition effects observed previously in this way : in the first 5 years, the labor demand was directed more toward low-skilled jobs and thus no strong composition effects occurred as the supply was sufficient in the zone but after 5 years and with the tightening of the local hiring condition, the demand turned to higher skills leading to an increase of residents with high degrees as there was probably not enough supply in the zone. This could have happened by attracting new residents with high degrees or retaining them if they were previously leaving the zone. It may also have been through an increase in the level of education of people in their studies at that time who might have been encouraged to further their education in order to take advantage of new opportunities. But as no effect is observed on the rate of 15-25 year olds residents nor in employment or studies, the last channel does not seem to be important whereas the first one, explored in the previous section, seems indeed to occur.

The effect on wages is also detailed by level of education in table 1.12. For low-degree owners, there is also a significant effect only after 2002, with and without control variables. As seen previously, the increase in employment for low-degree owners occurred at the start of the program. One consistent story is that the program raised the demand for low-skilled workers but, since their supply was quite high as many were unemployed, it first only had an effect on their employment. After a while, as the more employable low-skilled workers found a job and the demand kept on increasing because of the tightening of the local hiring condition, this translated into an increase in their wages.

For medium-degree owners, there is also a significant effect on wages only after 2002 but not significant when adding controls. Globally effects on medium-degree owners are similar to low-degree owners but are more often not significant, so the programs seems to impact them less strongly.

For high-degree owners, there is a significant negative effect on wages in the first 5 years. This could be explained by selection issues. The jobs occupied by residents with a high-degree due to the program were less paid than the jobs occupied by high degree owners without the program. This might be due to the fact that it was not the same type of jobs and/or that it was not the same type of high-degree owners. They may have unobserved characteristics that could explained a lower wage. The positive effect on wages after 2002 is very high and significant.

When estimating a time trend, it is also very significant, so the effect might be due to a progressive effect of the program rather than a direct effect of the local hiring condition. If the additional high-degree residents due to the program had different unobserved characteristics or different type of jobs, this may explained the positive effect on wages. It might be due to the fact that the demand for high-skilled jobs increased in the long term in the zone and that it both attracted and/or retained high-degree owners in the zone, decreased their unemployment rate and increased their wages.

Table 1.11: DD estimations for labor market outcomes by education level

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Unemployment rate high-degree owners | | | |
| ZFU1G × post97 | $-0.058$ | $-0.052$ | $0.056$ | $0.034$ |
| | (0.052) | (0.050) | (0.058) | (0.057) |
| ZFU1G × post2002 | | | $-0.156^{***}$ | $-0.119^{**}$ |
| | | | (0.052) | (0.051) |
| obs. (sampling areas × year) | 1654 | 1654 | 1654 | 1654 |
| $R^2$ | 0.269 | 0.336 | 0.272 | 0.338 |
| | Unemployment rate of medium-degree owners | | | |
| ZFU1G × post97 | $-0.083^{**}$ | $-0.049$ | $-0.058$ | $-0.048$ |
| | (0.036) | (0.032) | (0.038) | (0.036) |
| ZFU1G × post2002 | | | $-0.035$ | $-0.002$ |
| | | | (0.040) | (0.040) |
| obs. (sampling areas × year) | 2505 | 2505 | 2505 | 2505 |
| $R^2$ | 0.191 | 0.269 | 0.191 | 0.269 |
| | Unemployment rate of low-degree owners | | | |
| ZFU1G × post97 | $-0.114^{***}$ | $-0.075^{***}$ | $-0.071^{**}$ | $-0.064^{**}$ |
| | (0.033) | (0.028) | (0.034) | (0.029) |
| ZFU1G × post2002 | | | $-0.061$ | $-0.016$ |
| | | | (0.038) | (0.033) |
| obs. (sampling areas × year) | 2536 | 2536 | 2536 | 2536 |
| $R^2$ | 0.299 | 0.390 | 0.299 | 0.390 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

Table 1.12: DD estimations on wages by education level

| | Log of 26-65 year old private sector hourly wage of high-degree owners | | | | | |
|---|---|---|---|---|---|---|
| ZFU1G × post97 | $-0.022$ | $-0.032$ | $-0.187^{*}$ | $-0.123$ | $-0.354^{**}$ | $-0.263^{*}$ |
| | (0.119) | (0.121) | (0.112) | (0.109) | (0.160) | (0.148) |
| ZFU1G × post2002 | | | $0.240^{*}$ | $0.132$ | | |
| | | | (0.144) | (0.123) | | |
| ZFU1G × post97 ×t | | | | | $0.060^{***}$ | $0.042^{**}$ |
| | | | | | (0.022) | (0.021) |
| obs. (sampling areas × year) | 590 | 590 | 590 | 590 | 590 | 590 |
| $R^2$ | 0.48 | 0.607 | 0.48 | 0.608 | 0.49 | 0.61 |
| | Log of 26-65 year old private sector hourly wage of medium-degree owners | | | | | |
| ZFU1G × post97 | $0.023$ | $0.019$ | $-0.035$ | $-0.020$ | $-0.012$ | $0.012$ |
| | (0.059) | (0.051) | (0.054) | (0.047) | (0.078) | (0.068) |
| ZFU1G × post2002 | | | $0.079^{*}$ | $0.054$ | | |
| | | | (0.044) | (0.040) | | |
| ZFU1G × post97 ×t | | | | | $0.006$ | $0.001$ |
| | | | | | (0.011) | (0.009) |
| obs. (sampling areas × year) | 1337 | 1337 | 1337 | 1337 | 1337 | 1337 |
| $R^2$ | 0.38 | 0.449 | 0.38 | 0.450 | 0.38 | 0.45 |
| | Log of 26-65 year old private sector hourly wage of low-degree owners | | | | | |
| ZFU1G × post97 | $0.057$ | $0.050$ | $0.002$ | $-0.007$ | $0.043$ | $0.045$ |
| | (0.047) | (0.046) | (0.040) | (0.040) | (0.060) | (0.058) |
| ZFU1G × post2002 | | | $0.079^{*}$ | $0.082^{**}$ | | |
| | | | (0.040) | (0.038) | | |
| ZFU1G × post97 ×t | | | | | $0.002$ | $0.001$ |
| | | | | | (0.009) | (0.009) |
| obs. (sampling areas × year) | 1375 | 1375 | 1375 | 1375 | 1375 | 1375 |
| $R^2$ | 0.39 | 0.431 | 0.39 | 0.432 | 0.39 | 0.43 |
| year fixed effects | yes | yes | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes | yes | yes |
| Control variables | no | yes | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

## 1.4 Sensitivity analysis

### 1.4.1 Placebo tests

The validity of the Difference-in-Difference strategy and the choice of the control group are tested through placebo tests. The four potential control groups presented in the evaluation strategy section are tested.

The idea of the placebo test is to verify that the treated and control groups are really similar in trend before the treatment of 1997. The test can be performed only if several years of observation before the treatment are available, as it is necessary to measure not only the difference between the two groups but also their time trends. The years 1993 to 1996 are used. A regression is then estimated with a "fake" or placebo treatment in the years 1994, 1995 and 1996 while controlling for the 1993 initial difference in level of the outcome between the two groups. Time and urban unit fixed effects are also included.

Tests can be run on various observable characteristics. Tables 1.13 and 1.14 show the results of these placebo tests for some socio-demographic characteristics used in the choice of the ZFU relatively to ZRU : age, education and the nationality of residents (the latter is not in the index but immigration issues are often mentioned in relation to urban issues). Placebo tests are also run for various labor market outcomes with and without control variables (tables 1.15 and 1.16) as both specifications are next estimated.

In almost no case is the placebo treatment for any possible control groups significant which means that the control and treated group do have similar trends on observable characteristics before the start of the program. A few years for some variables are slightly significant but without a pattern except for the share of people with a low degree when using the ZRU that will be ZFU in the second and third generation as a control group. The identification strategy thus appears valid, except for the future ZFU. They are thus not used as a control group. A criteria to choose among valid control groups is the number of observations : we wish to retain enough observations to have power in the estimations. For this reason, all the ZRU could have been kept but the possibility for those belonging to the same urban unit of a ZFU of being impacted by the program is too strong and they would contribute only before 2002 as after that date they are excluded because of the modification of the hiring condition that impacts them. So, finally, ZRU that are not in the same urban unit of a ZFU is the preferred control group.

Table 1.13: Placebo estimations for the effect of ZFU1G on socio demographic characteristics

| | all ZRU | ZRU not in UU of ZFU | future ZFU 2G/3G not in UU of ZFU | matched ZRU not in UU of ZFU |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Age | |
| ZFU1G × 1994 | 0.300 | 0.072 | −0.362 | 0.111 |
| | (0.519) | (0.509) | (0.881) | (0.913) |
| ZFU1G × 1995 | 0.484 | 0.033 | 0.020 | 0.878 |
| | (0.733) | (0.758) | (1.177) | (1.258) |
| ZFU1G × 1996 | 0.778 | 0.307 | 0.352 | 1.544 |
| | (0.939) | (0.959) | (1.657) | (1.753) |
| obs. (sampling areas × year) | 558 | 390 | 197 | 177 |
| | | | Share of 15-25 year old residents | |
| ZFU1G × 1994 | −0.013 | 0.002 | −0.003 | 0.002 |
| | (0.024) | (0.024) | (0.031) | (0.031) |
| ZFU1G × 1995 | −0.015 | 0.005 | −0.027 | −0.031 |
| | (0.036) | (0.036) | (0.045) | (0.044) |
| ZFU1G × 1996 | −0.008 | 0.008 | −0.010 | −0.012 |
| | (0.041) | (0.039) | (0.052) | (0.055) |
| obs. (sampling areas × year) | 558 | 390 | 197 | 177 |
| | | | Share not from EEC | |
| ZFU1G × 1994 | 0.004 | 0.003 | −0.036 | −0.033 |
| | (0.034) | (0.028) | (0.039) | (0.037) |
| ZFU1G × 1995 | −0.027 | −0.017 | −0.068 | −0.074 |
| | (0.061) | (0.039) | (0.049) | (0.053) |
| ZFU1G × 1996 | −0.048 | −0.041 | −0.063 | −0.077 |
| | (0.069) | (0.051) | (0.071) | (0.082) |
| obs. (sampling areas × year) | 558 | 390 | 197 | 177 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-1996, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.14: Placebo estimations for the effect of ZFU1G on the share of education groups

| | all ZRU | ZRU not in UU of ZFU | future ZFU 2G/3G not in UU of ZFU | matched ZRU not in UU of ZFU |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | Share with high degree | | |
| ZFU1G × 1994 | −0.001 | 0.007 | 0.054 | 0.007 |
| | (0.012) | (0.012) | (0.036) | (0.023) |
| ZFU1G × 1995 | 0.008 | 0.009 | 0.063 | 0.024 |
| | (0.021) | (0.022) | (0.043) | (0.036) |
| ZFU1G × 1996 | 0.005 | 0.012 | 0.060 | 0.003 |
| | (0.025) | (0.029) | (0.056) | (0.047) |
| obs. (sampling areas × year) | 557 | 389 | 196 | 176 |
| | | Share with medium degree | | |
| ZFU1G × 1994 | 0.015 | 0.001 | 0.022 | 0.014 |
| | (0.021) | (0.019) | (0.030) | (0.030) |
| ZFU1G × 1995 | 0.023 | 0.024 | 0.042 | 0.009 |
| | (0.033) | (0.028) | (0.044) | (0.052) |
| ZFU1G × 1996 | 0.060* | 0.057** | 0.045 | 0.017 |
| | (0.034) | (0.029) | (0.048) | (0.046) |
| obs. (sampling areas × year) | 557 | 389 | 196 | 176 |
| | | Share with low degree | | |
| ZFU1G × 1994 | −0.014 | −0.008 | −0.076** | −0.021 |
| | (0.022) | (0.021) | (0.029) | (0.033) |
| ZFU1G × 1995 | −0.031 | −0.034 | −0.105** | −0.033 |
| | (0.038) | (0.033) | (0.045) | (0.056) |
| ZFU1G × 1996 | −0.064 | −0.069* | −0.105** | −0.020 |
| | (0.040) | (0.037) | (0.049) | (0.055) |
| obs. (sampling areas × year) | 557 | 389 | 196 | 176 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-1996, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.15: Placebo estimations for the effect of ZFU1G on labor market outcomes

| | all ZRU | ZRU not in UU of ZFU | future ZFU 2G/3G not in UU of ZFU | matched ZRU not in UU of ZFU |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Unemployment rate | |
| ZFU1G × 1994 | −0.014 | −0.020 | −0.039 | −0.067* |
| | (0.028) | (0.028) | (0.038) | (0.035) |
| ZFU1G × 1995 | −0.005 | −0.009 | −0.046 | −0.071 |
| | (0.044) | (0.041) | (0.046) | (0.045) |
| ZFU1G × 1996 | 0.001 | −0.009 | −0.046 | −0.067 |
| | (0.052) | (0.049) | (0.055) | (0.058) |
| obs. (sampling areas × year) | 557 | 389 | 196 | 176 |
| | | | 26-65 year old unemployment rate | |
| ZFU1G × 1994 | −0.005 | 0.001 | −0.045 | −0.044 |
| | (1.000) | (1.000) | (1.000) | (1.000) |
| ZFU1G × 1995 | 0.007 | 0.015 | −0.031 | −0.036 |
| | (1.000) | (1.000) | (1.000) | (1.000) |
| ZFU1G × 1996 | 0.020 | 0.009 | −0.034 | −0.048 |
| | (1.000) | (1.000) | (1.000) | (1.000) |
| obs. (sampling areas × year) | 556 | 388 | 195 | 175 |
| | | | 26-65 year old employment rate | |
| ZFU1G × 1994 | −0.002 | −0.007 | 0.046 | 0.033 |
| | (0.028) | (0.028) | (0.036) | (0.034) |
| ZFU1G × 1995 | −0.026 | −0.026 | 0.031 | 0.044 |
| | (0.045) | (0.040) | (0.051) | (0.048) |
| ZFU1G × 1996 | −0.055 | −0.033 | −0.002 | −0.026 |
| | (0.051) | (0.046) | (0.057) | (0.058) |
| obs. (sampling areas × year) | 558 | 390 | 197 | 177 |
| | | | Share of 15-25 year olds not in employment nor studies | |
| ZFU1G × 1994 | −0.048 | −0.063* | 0.034 | −0.062 |
| | (0.034) | (0.035) | (0.045) | (0.059) |
| ZFU1G × 1995 | −0.034 | −0.070 | −0.014 | −0.063 |
| | (0.046) | (0.044) | (0.049) | (0.051) |
| ZFU1G × 1996 | −0.068 | −0.074 | −0.020 | −0.060 |
| | (0.048) | (0.045) | (0.064) | (0.070) |
| obs. (sampling areas × year) | 546 | 382 | 191 | 175 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-1996, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.16: Placebo estimations for the effect of ZFU1G on labor market outcomes with controls

| | all ZRU | ZRU not in UU of ZFU | future ZFU 2G/3G not in UU of ZFU | matched ZRU not in UU of ZFU |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Unemployment rate | |
| ZFU1G × 1994 | −0.001 | −0.009 | 0.002 | −0.045 |
| | (0.025) | (0.027) | (0.041) | (0.032) |
| ZFU1G × 1995 | 0.027 | 0.012 | 0.006 | −0.033 |
| | (0.036) | (0.037) | (0.043) | (0.044) |
| ZFU1G × 1996 | 0.042 | 0.027 | 0.017 | −0.036 |
| | (0.042) | (0.044) | (0.054) | (0.051) |
| obs. (sampling areas × year) | 557 | 389 | 196 | 176 |
| | | | 26-65 year old unemployment rate | |
| ZFU1G × 1994 | 0.012 | 0.017 | −0.013 | −0.032 |
| | (0.027) | (0.029) | (0.044) | (0.038) |
| ZFU1G × 1995 | 0.036 | 0.036 | 0.004 | −0.013 |
| | (0.036) | (0.037) | (0.044) | (0.048) |
| ZFU1G × 1996 | 0.058 | 0.045 | 0.009 | −0.026 |
| | (0.044) | (0.046) | (0.056) | (0.055) |
| obs. (sampling areas × year) | 556 | 388 | 195 | 175 |
| | | | 26-65 year old employment rate | |
| ZFU1G × 1994 | −0.013 | −0.011 | 0.002 | 0.010 |
| | (0.023) | (0.023) | (0.039) | (0.034) |
| ZFU1G × 1995 | −0.047 | −0.039 | −0.024 | 0.000 |
| | (0.029) | (0.027) | (0.035) | (0.032) |
| ZFU1G × 1996 | −0.079** | −0.057* | −0.051 | −0.024 |
| | (0.034) | (0.033) | (0.046) | (0.041) |
| obs. (sampling areas × year) | 558 | 390 | 197 | 177 |
| | | | Share of 15-25 year olds not in employment nor studies | |
| ZFU1G × 1994 | −0.042 | −0.056** | 0.041 | −0.057 |
| | (0.027) | (0.027) | (0.034) | (0.053) |
| ZFU1G × 1995 | −0.007 | −0.032 | 0.029 | −0.028 |
| | (0.041) | (0.038) | (0.040) | (0.059) |
| ZFU1G × 1996 | −0.025 | −0.023 | 0.048 | −0.038 |
| | (0.041) | (0.039) | (0.051) | (0.066) |
| obs. (sampling areas × year) | 546 | 382 | 191 | 175 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | yes | yes | yes | yes |

Source : French Labor Force Survey, 1993-1996, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

### 1.4.2 Robustness checks

A first set of robustness checks is performed using the two other possible control groups that were not rejected by placebo tests. Table 1.17 shows the estimations of the main results when using all ZRU as a control group rather than ZRU not in the same urban unit than a ZFU1G.[21] Results are very similar although in a few cases, they do not reach the same level of significance. Table 1.17 shows also the main estimations when using matched ZRU as a control group.[22] The main result on unemployment is lower although not significantly different. In general a lot of significance is lost as the number of observations is divided by more than 2.

A second set of robustness checks is done using different period of study : 1993-2003 (before the start of ZFU of second generation) and 1993-2011 (last year available); see table 1.17 and appendix. Results are very similar except that estimations regarding the local hiring condition are quite weak in the case where only 2 years are used (2002 and 2003).

Globally, results are quite robust to a change of the control group or of the period of study.

[21]The other estimations are available in appendix.
[22]The other estimations are available in appendix.

Table 1.17: DD estimations for unemployment, robustness checks

| | Unemployment rate | | | | | |
|---|---|---|---|---|---|---|
| | Period of estimation : 1993-2003 | | | | | |
| ZFU1G × post1997 | $-0.089^{***}$ | $-0.066^{***}$ | $-0.052^{*}$ | $-0.054^{**}$ | $-0.028$ | $-0.045$ |
| | (0.029) | (0.024) | (0.028) | (0.023) | (0.034) | (0.028) |
| ZFU1G × post2002 | | | $-0.061^{*}$ | $-0.019$ | | |
| | | | (0.035) | (0.029) | | |
| ZFU1G × post97 ×t | | | | | $-0.014^{*}$ | $-0.005$ |
| | | | | | (0.008) | (0.007) |
| obs. (sampling areas × year) | 1520 | 1520 | 1520 | 1520 | 1520 | 1520 |
| $R^2$ | 0.409 | 0.574 | 0.411 | 0.575 | 0.411 | 0.575 |
| | Period of estimation : 1993-2011 | | | | | |
| ZFU1G × post1997 | $-0.102^{***}$ | $-0.051^{**}$ | $-0.055^{*}$ | $-0.047^{**}$ | $-0.118^{***}$ | $-0.062^{**}$ |
| | (0.028) | (0.022) | (0.028) | (0.022) | (0.041) | (0.031) |
| ZFU1G × post2002 | | | $-0.058^{**}$ | $-0.006$ | | |
| | | | (0.027) | (0.020) | | |
| ZFU1G × post97 ×t | | | | | 0.002 | 0.001 |
| | | | | | (0.004) | (0.003) |
| obs. (sampling areas × year) | 4152 | 4152 | 4152 | 4152 | 4152 | 4152 |
| $R^2$ | 0.296 | 0.460 | 0.297 | 0.460 | 0.296 | 0.460 |
| | All ZRU as control group | | | | | |
| ZFU1G × post1997 | $-0.090^{***}$ | $-0.041^{*}$ | $-0.037$ | $-0.036^{*}$ | $-0.063$ | $-0.051$ |
| | (0.028) | (0.022) | (0.027) | (0.021) | (0.040) | (0.033) |
| ZFU1G × post2002 | | | $-0.076^{**}$ | $-0.007$ | | |
| | | | (0.030) | (0.023) | | |
| ZFU1G × post97 ×t | | | | | $-0.005$ | 0.002 |
| | | | | | (0.006) | (0.005) |
| obs. (sampling areas × year) | 3074 | 3074 | 3074 | 3074 | 3074 | 3074 |
| $R^2$ | 0.295 | 0.458 | 0.297 | 0.458 | 0.296 | 0.458 |
| | Matched ZRU as control group | | | | | |
| ZFU1G × post1997 | $-0.058^{*}$ | $-0.040$ | 0.005 | $-0.002$ | $-0.011$ | 0.002 |
| | (0.032) | (0.028) | (0.036) | (0.031) | (0.056) | (0.055) |
| ZFU1G × post2002 | | | $-0.088^{**}$ | $-0.055$ | | |
| | | | (0.037) | (0.036) | | |
| ZFU1G × post97 ×t | | | | | $-0.009$ | $-0.008$ |
| | | | | | (0.009) | (0.010) |
| obs. (sampling areas × year) | 1105 | 1105 | 1105 | 1105 | 1105 | 1105 |
| $R^2$ | 0.338 | 0.474 | 0.341 | 0.475 | 0.339 | 0.475 |
| year fixed effects | yes | yes | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes | yes | yes |
| Control variables | no | yes | no | yes | no | yes |

Source : French Labor Force Survey. 1993-2003, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

# Conclusion

To conclude, this chapter shows that the ZFU program significantly decreased unemployment among residents, by more than 11%. Since the starting level was about 30%, this brought the ZFU unemployment rate close to the level of the control group, but unemployment remains much higher than in the rest of the country. This benefit was due both to an improvement of the situation of "original" residents of the zones and to social composition effects. So there is clear evidence that the ZFU program was beneficial to the zones, even if it was probably not enough. It is much less clear if the ZFU program was beneficial to the whole economy.

There is evidence that the program helped to attract or retain residents with high degrees, which can be taken as evidence that workers are mobile. The theory (Kline and Moretti (2014) states that, in that case, the EZ credits are capitalized in land prices. In the US, there is indeed some evidence that EZ program led to an increase in land prices (Freedman (2012), Krupka and Noonan (2009)). For France, Poulhes (2015) showed that there was an increase on commercial property values, whereas Gregoir and Maury (2012) found a decrease in housing values on a small subsample of ZFU. Further research is needed but it is plausible that indeed a part of the ZFU program was capitalized into land prices. It is a welfare loss if land owners and ZFU residents are separate, which is probably the case as the share of social housing is very high in EZ. However, a change in social composition can be positive for the neighborhood if it leads, for example, to positive peer effects and this is not taken into account in the existing theoretical modeling of EZ.

The effect is not totally due to composition effects and the ZFU program seemed to have improved the situation of some local residents. It could correspond to two cases of Kline and Moretti (2014) welfare analysis. Either inequalities between zones were due to some market imperfections such as the presence of hiring costs and then EZ is efficient and increases welfare. Either there are differences in local productivity and workers are not fully mobile, then EZ is only a redistributive tool and there is no total welfare gain.

Last, the local hiring condition seems to be effective, as the effect of the program was stronger when the condition was made more rigorous, and there was a positive effect of the program on long term contracts, which are the type of labor contracts stipulated in the condition. This hints that the deprived situation of the EZ is not only due to spatial mismatch. As the tightening of the hiring clause led to an increase in the share of high degree workers, it is plausible that the adequation between the level of skills of EZ residents and job offers is a more serious issue. From a public policy point of view, it might therefore be more efficient to attach benefits to people rather than to places. The French government is in fact experimenting with a new policy

of “emplois francs” (roughly, “free-range jobs”) in which hiring subsidies are linked to the residents of deprived zones whatever the location of their workplace.

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# Appendices

# 1.A Complementary results on data and methodology

Table 1.18: ZFU and ZRU exemptions in 1997

| | ZRU | ZFU |
|---|---|---|
| Payroll tax | 1 year exemption<br>- within a limit of 50 employees and 1.5 minimum wage<br>- for long term contracts | 5 years of exemption<br>- within a limit of 50 employees and 1.5 minimum wage<br>- local hiring condition from the 3rd employee<br>- for long term contracts<br>- firms of less than 50 employees at their date of creation<br>- some activities are excluded |
| Individual social charges (health system) of artisans and tradespeople | no | 5 years of exemption<br><br>- within a limit of 1.5 minimum wage |
| Local business tax | 5 years of exemption<br>- est. of less than 150 employees<br><br>- within a limit determined yearly (990 kF or roughly 151 kEuros in 2000 , half for est. already existing)<br>- whatever the activity | 5 years of exemption<br>- firms of less than 50 employees at their date of creation<br>- within a limit determined yearly (2835 kF or roughly 432 kEuros in 2000)<br><br>- some activities are excluded |
| Profit tax | 5 years of exemption<br>- restricted to new firms<br><br>- degressive : 100% for year 1 and 2, 75 % for year 3, 50 % for year 4, 25 % for year 5<br>- within a limit since 2000<br><br>- no employees number restriction | 5 years of exemption<br>- for new firms and firms existing the 01/01/1997<br><br>- within a limit of 400 000 F or roughly 61 000 Euros for the yearly profit<br>- no employees number restriction |
| Tax on properties | no | 5 years of exemption for business properties |
| Specific Paris region tax on creation of offices | no | exemption |
| Transfer rights for acquisitions of businesses | exemptions up to 700 000 F<br><br>or roughly 107 000 Euros | exemptions up to 700 000 F<br><br>or roughly 107 000 Euros |

Table 1.19: Characteristics of ZRU and approximated ZRU in 1990

| | ZRU | Approximated ZRU |
|---|---|---|
| Average age | 31 | 31 |
| Share of under 25 year old | 48% | 47% |
| Share of men | 47% | 47% |
| Share of no diplomas | 58% | 58% |
| Unemployment rate | 19% | 18% |
| Unemployment rate of 15-25 year old | 30% | 29% |
| Share of 15-25 years old studying | 48% | 48% |
| Share of 15-25 years old not in employment nor studying | 20% | 20% |
| Share of foreigners from EEC | 3% | 3% |
| Share of foreigners from outside EEC | 15% | 14% |
| Share of French by naturalization | 5% | 4% |
| Share of French by birth | 75% | 75% |
| Share of public housing | 67% | 64% |
| Number of persons per room of the dwelling | 1.05 | 1.04 |
| Average population size of a zone | 7221 | 6612 |

Source : 1990 Census

1990 European Economic Community definition is used : the members are Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom.

Table 1.20: Characteristics of ZUS and ZFU1G in 1999 : comparison of LFS and Census

(a) ZUS

| | 1999 Census | 1999 LFS | |
|---|---|---|---|
| | | Estimate | Std. Err |
| Average age | 36.3 | 36.9 | 0.3 |
| Share of under 25 year old | 27.3% | 26.1% | 0.9% |
| Share of men | 48.5% | 47.8% | 0.6% |
| Share of no diplomas | 43.7% | 42.0% | 1.3% |
| Unemployment rate | 25.9% | 24.8% | 1.3% |
| Share of 15-25 years old studying | 56.8% | 58.9% | 1.8% |
| Share of 15-25 years old not in employment nor studying | 20.6% | 21.4% | 1.4% |
| Share of foreigners from European Economic Community | 2.8% | 2.4% | 0.3% |
| Share of foreigners from outside EEC | 15.2% | 16.6% | 1.6% |

(b) ZFU1G

| | 1999 Census | 1999 LFS | |
|---|---|---|---|
| | | Estimate | Std. Err |
| Average age | 35.8 | 35.8 | 0.7 |
| Share of under 25 year old | 29.2% | 29.3% | 2.6% |
| Share of men | 48.6% | 48.4% | 1.5% |
| Share of no diplomas | 48.0% | 44.0% | 3.1% |
| Unemployment rate | 30.2% | 28.0% | 3.2% |
| Share of 15-25 years old studying | 57.2% | 54.5% | 5.2% |
| Share of 15-25 years old not in employment nor studying | 22.3% | 27.0% | 3.6% |
| Share of foreigners from European Economic Community | 2.8% | 2.3% | 0.8% |
| Share of foreigners from outside EEC | 19.6% | 22.4% | 3.5% |

Source : 1999 Census and 1999 Labor Force Survey, 15-65 year old population

The variance of the LFS estimations is computed as explained in the econometric method section, taking into account the design of the survey and potential serial and spatial correlation.

1999 European Economic Community (except Finland) definition is used : the members are Austria, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

Table 1.21: Parameters of the matching equation :Probability of a ZRU of being a ZFU1G

| | Unemployment rate |
|---|---|
| Intercept | $-6.58^{***}$ |
| | (1.19) |
| unemployment rate | 1.29 |
| | (1.98) |
| share of 15-25 year old | $5.85^{**}$ |
| | (2.30) |
| size of population in thousands | $0.11^{***}$ |
| | (0.02) |
| share of not from EEC | 0.70 |
| | (0.63) |
| share of no degree | 0.55 |
| | (1.47) |
| Observations | 550 |
| Percent Concordant | 92 |

Source : French Census 1990

Logistic model, *** significant at 1%. ** significant at 5%. * significant at 10%

The 1997 ZFU were chosen among the ZRU, partly according to an index computed with information from the 1990 Census (the unemployment computed with information from the 1990 Census (the unemploymentrate, the proportion of residents under 25, the proportion of residents without a diploma) and the average tax potential of the city (tax data). Using a logistic estimation (see figures1.21), a score is computed with census information and the ZFU are matched with the closest ZRU not belonging to the same urban unit than a ZFU according to this score. The unemployment rate in 1990, the share of 15-25 year olds and the share of no diploma are used, as in the index. The tax information is not available. The size of the zone in terms of population is also added as the ZFU were supposed to have at least 10 000 residents and the share of foreigners born outside the European economic community as these deprived neighboorhoods have a concentration of low-skilled immigrants. 1990 European Economic Community definition is used : the members are Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom.

# 1.B Complementary results : test of a trend in the effect of the program

Table 1.22: DD estimations of the effect on the share of new residents

| | Share of new residents | Share of new residents from outside the municipality | Share of new residents from within the same municipality |
|---|---|---|---|
| ZFU1G × post97 | $-0.012$ | $0.000$ | $-0.012$ |
| | $(0.018)$ | $(0.011)$ | $(0.012)$ |
| ZFU1G × post2002 | $-0.005$ | $-0.008$ | $0.004$ |
| | $(0.017)$ | $(0.011)$ | $(0.011)$ |
| obs. (sampling areas × year) | 2713 | 2713 | 2713 |
| $R^2$ | 0.19 | 0.14 | 0.16 |
| year fixed effects | yes | yes | yes |
| UU fixed effects | yes | yes | yes |
| Control variables | no | no | no |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.23: DD estimations for job characteristics with a trend

| | | |
|---|---|---|
| | Share among 26-65 years old of private sector workers | |
| ZFU1G × post97 | 0.058 | 0.074** |
| | (0.043) | (0.037) |
| ZFU1G × post97 ×t | 0.002 | −0.002 |
| | (0.007) | (0.006) |
| obs. (sampling areas × year) | 2702 | 2702 |
| $R^2$ | 0.238 | 0.378 |
| | Share among 26-65 years old of private sector workers with long term contracts | |
| ZFU1G × post97 | 0.051 | 0.068* |
| | (0.042) | (0.038) |
| ZFU1G × post97 ×t | 0.002 | −0.002 |
| | (0.007) | (0.006) |
| obs. (sampling areas × year) | 2702 | 2702 |
| $R^2$ | 0.257 | 0.374 |
| | share among 26-65 years old of private sector high-skilled jobs | |
| ZFU1G × post97 | 0.013 | 0.011 |
| | (0.016) | (0.013) |
| ZFU1G × post97 ×t | 0.003 | 0.000 |
| | (0.002) | (0.002) |
| obs. (sampling areas × year) | 2702 | 2702 |
| $R^2$ | 0.220 | 0.451 |
| | share among 26-65 years old of private sector medium-skilled jobs | |
| ZFU1G × post97 | 0.057** | 0.052*** |
| | (0.023) | (0.019) |
| ZFU1G × post97 ×t | −0.003 | −0.005 |
| | (0.004) | (0.003) |
| obs. (sampling areas × year) | 2702 | 2702 |
| $R^2$ | 0.200 | 0.346 |
| | share among 26-65 years old of private sector low-skilled jobs | |
| ZFU1G × post97 | −0.010 | 0.016 |
| | (0.041) | (0.032) |
| ZFU1G × post97 ×t | −0.001 | −0.001 |
| | (0.006) | (0.005) |
| obs. (sampling areas × year) | 2702 | 2702 |
| $R^2$ | 0.267 | 0.389 |
| year fixed effects | yes | yes |
| UU fixed effects | yes | yes |
| Control variables | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

Table 1.24: DD estimations of the effect on age and education with a trend

| | All | New residents | New residents from other municipalities | New residents from the same municipality |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Age | |
| ZFU1G × post97 | 1.831 | 0.368 | −0.473 | 1.833 |
| | (1.296) | (1.271) | (1.882) | (1.412) |
| ZFU1G × post97× t | 0.039 | −0.121 | −0.193 | −0.275 |
| | (0.195) | (0.210) | (0.286) | (0.248) |
| obs. (sampling areas × year) | 2713 | 1387 | 927 | 1080 |
| $R^2$ | 0.35 | 0.22 | 0.31 | 0.25 |
| | | | Share of 15-25 year old | |
| ZFU1G × post97 | −0.012 | −0.007 | 0.087 | −0.064 |
| | (0.037) | (0.065) | (0.105) | (0.066) |
| ZFU1G × post97× t | −0.003 | −0.002 | −0.021 | 0.013 |
| | (0.006) | (0.009) | (0.015) | (0.011) |
| obs. (sampling areas × year) | 2713 | 1387 | 927 | 1080 |
| $R^2$ | 0.27 | 0.25 | 0.33 | 0.27 |
| | | | Share with a high degree | |
| ZFU1G × post97 | 0.026 | 0.057 | −0.010 | 0.070 |
| | (0.040) | (0.051) | (0.084) | (0.053) |
| ZFU1G × post97× t | 0.006 | 0.007 | 0.025* | 0.000 |
| | (0.006) | (0.008) | (0.013) | (0.010) |
| obs. (sampling areas × year) | 2711 | 1342 | 846 | 1052 |
| $R^2$ | 0.26 | 0.21 | 0.26 | 0.25 |
| | | | Share with a medium degree | |
| ZFU1G × post97 | 0.000 | 0.013 | −0.038 | 0.061 |
| | (0.042) | (0.056) | (0.094) | (0.068) |
| ZFU1G × post97× t | 0.000 | −0.008 | −0.003 | −0.014 |
| | (0.006) | (0.008) | (0.015) | (0.011) |
| obs. (sampling areas × year) | 2711 | 1342 | 846 | 1052 |
| $R^2$ | 0.33 | 0.20 | 0.25 | 0.23 |
| | | | Share with a low degree | |
| ZFU1G × post97 | −0.026 | −0.070 | 0.048 | −0.131* |
| | (0.063) | (0.065) | (0.098) | (0.070) |
| ZFU1G × post97× t | −0.006 | 0.001 | −0.022 | 0.014 |
| | (0.008) | (0.010) | (0.016) | (0.011) |
| obs. (sampling areas × year) | 2711 | 1342 | 846 | 1052 |
| $R^2$ | 0.37 | 0.26 | 0.30 | 0.30 |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

# 1.C Complementary results for robustness checks

Table 1.25: DD estimations of the effect on age and education, 1993-2003

| | All | New residents | New residents from other municipalities | New residents from the same municipality |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Age | |
| ZFU1G × post97 | 0.549 | 0.435 | −0.310 | 1.375 |
| | (0.714) | (1.033) | (1.525) | (1.101) |
| ZFU1G × post2002 | 2.887** | −1.170 | 0.718 | −1.619 |
| | (1.135) | (1.147) | (1.766) | (1.479) |
| obs. (sampling areas × year) | 1538 | 1387 | 727 | 1080 |
| $R^2$ | 0.45 | 0.22 | 0.28 | 0.25 |
| | | | Share of 15-25 year olds | |
| ZFU1G × post97 | −0.003 | −0.008 | 0.028 | −0.042 |
| | (0.025) | (0.056) | (0.084) | (0.055) |
| ZFU1G × post2002 | −0.045 | −0.015 | −0.172 | 0.074 |
| | (0.032) | (0.055) | (0.111) | (0.064) |
| obs. (sampling areas × year) | 1538 | 1387 | 727 | 1080 |
| $R^2$ | 0.30 | 0.25 | 0.31 | 0.27 |
| | | | Share with a high degree | |
| ZFU1G × post97 | 0.009 | 0.055 | 0.015 | 0.070* |
| | (0.024) | (0.039) | (0.072) | (0.036) |
| ZFU1G × post2002 | 0.064** | 0.035 | 0.038 | −0.001 |
| | (0.031) | (0.079) | (0.108) | (0.060) |
| obs. (sampling areas × year) | 1536 | 1017 | 665 | 1052 |
| $R^2$ | 0.43 | 0.26 | 0.32 | 0.25 |
| | | | Share with a medium degree | |
| ZFU1G × post97 | −0.012 | −0.039 | −0.087 | −0.021 |
| | (0.026) | (0.048) | (0.080) | (0.057) |
| ZFU1G × post2002 | −0.029 | 0.041 | 0.200 | −0.058 |
| | (0.037) | (0.085) | (0.130) | (0.078) |
| obs. (sampling areas × year) | 1536 | 1017 | 665 | 823 |
| $R^2$ | 0.39 | 0.22 | 0.28 | 0.24 |
| | | | Share with a low degree | |
| ZFU1G × post97 | 0.003 | −0.016 | 0.072 | −0.051 |
| | (0.036) | (0.054) | (0.081) | (0.057) |
| ZFU1G × post2002 | −0.035 | −0.076 | −0.238** | 0.067 |
| | (0.052) | (0.085) | (0.101) | (0.108) |
| obs. (sampling areas × year) | 1536 | 1017 | 665 | 823 |
| $R^2$ | 0.44 | 0.30 | 0.37 | 0.28 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-2003, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.26: DD estimations of the effect on age and education,1993-2011

| | All | New residents | New residents from other municipalities | New residents from the same municipality |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Age | |
| ZFU1G × post97 | 0.906 | 0.483 | −0.392 | 1.260 |
| | (0.678) | (1.098) | (1.800) | (1.129) |
| ZFU1G × post2002 | 1.150 | −1.335 | −1.008 | −1.821 |
| | (0.831) | (1.015) | (1.439) | (1.381) |
| obs. (sampling areas × year) | 4233 | 1803 | 1167 | 1369 |
| $R^2$ | 0.28 | 0.21 | 0.30 | 0.25 |
| | | | Share of 15-25 year olds | |
| ZFU1G × post97 | −0.014 | −0.004 | 0.038 | −0.039 |
| | (0.024) | (0.058) | (0.096) | (0.057) |
| ZFU1G × post2002 | −0.025 | 0.002 | −0.053 | 0.064 |
| | (0.024) | (0.045) | (0.071) | (0.055) |
| obs. (sampling areas × year) | 4233 | 1803 | 1167 | 1369 |
| $R^2$ | 0.27 | 0.27 | 0.34 | 0.25 |
| | | | Share with a high degree | |
| ZFU1G × post97 | 0.007 | 0.040 | −0.009 | 0.078** |
| | (0.024) | (0.040) | (0.071) | (0.036) |
| ZFU1G × post2002 | 0.067*** | 0.036 | 0.141* | −0.029 |
| | (0.024) | (0.046) | (0.077) | (0.049) |
| obs. (sampling areas × year) | 4215 | 1731 | 1060 | 1325 |
| $R^2$ | 0.27 | 0.19 | 0.23 | 0.21 |
| | | | Share with a medium degree | |
| ZFU1G × post97 | −0.010 | −0.023 | −0.019 | −0.014 |
| | (0.024) | (0.047) | (0.078) | (0.060) |
| ZFU1G × post2002 | −0.017 | −0.002 | −0.023 | 0.003 |
| | (0.024) | (0.045) | (0.076) | (0.057) |
| obs. (sampling areas × year) | 4215 | 1731 | 1060 | 1325 |
| $R^2$ | 0.31 | 0.21 | 0.23 | 0.24 |
| | | | Share with a low degree | |
| ZFU1G × post97 | 0.003 | −0.017 | 0.029 | −0.064 |
| | (0.034) | (0.054) | (0.083) | (0.063) |
| ZFU1G × post2002 | −0.050 | −0.035 | −0.118 | 0.027 |
| | (0.035) | (0.055) | (0.081) | (0.068) |
| obs. (sampling areas × year) | 4215 | 1731 | 1060 | 1325 |
| $R^2$ | 0.36 | 0.26 | 0.32 | 0.30 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-2011, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.27: DD estimations of the effect on age and education, all ZRU as control goup

| | All | New residents | New residents from other municipalities | New residents from the same municipality |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | Age | | |
| ZFU1G × post97 | 0.652 | −0.058 | −0.133 | −0.187 |
| | (0.633) | (0.202) | (0.270) | (0.238) |
| ZFU1G × post2002 | 1.990** | −0.271 | −0.771 | 0.925 |
| | (0.906) | (1.195) | (1.776) | (1.330) |
| obs. (sampling areas × year) | 3119 | 1708 | 1138 | 1336 |
| $R^2$ | 0.35 | 0.20 | 0.28 | 0.22 |
| | | Share of 15-25 year olds | | |
| ZFU1G × post97 | −0.005 | −0.005 | −0.020 | 0.009 |
| | (0.023) | (0.009) | (0.014) | (0.011) |
| ZFU1G × post2002 | −0.030 | 0.005 | 0.055 | −0.029 |
| | (0.028) | (0.061) | (0.097) | (0.063) |
| obs. (sampling areas × year) | 3119 | 1708 | 1138 | 1336 |
| $R^2$ | 0.26 | 0.23 | 0.30 | 0.25 |
| | | Share with a high degree | | |
| ZFU1G × post97 | 0.010 | 0.007 | 0.023* | 0.001 |
| | (0.019) | (0.007) | (0.013) | (0.009) |
| ZFU1G × post2002 | 0.073*** | 0.054 | −0.001 | 0.059 |
| | (0.027) | (0.047) | (0.079) | (0.047) |
| obs. (sampling areas × year) | 3117 | 1655 | 1045 | 1300 |
| $R^2$ | 0.26 | 0.20 | 0.23 | 0.24 |
| | | Share with a medium degree | | |
| ZFU1G × post97 | −0.009 | −0.007 | −0.006 | −0.010 |
| | (0.026) | (0.008) | (0.014) | (0.010) |
| ZFU1G × post2002 | 0.021 | 0.005 | −0.023 | 0.033 |
| | (0.030) | (0.055) | (0.088) | (0.066) |
| obs. (sampling areas × year) | 3117 | 1655 | 1045 | 1300 |
| $R^2$ | 0.32 | 0.18 | 0.23 | 0.21 |
| | | Share with a low degree | | |
| ZFU1G × post97 | −0.001 | 0.000 | −0.018 | 0.009 |
| | (0.034) | (0.010) | (0.016) | (0.010) |
| ZFU1G × post2002 | −0.094** | −0.059 | 0.024 | −0.091 |
| | (0.042) | (0.062) | (0.092) | (0.069) |
| obs. (sampling areas × year) | 3117 | 1655 | 1045 | 1300 |
| $R^2$ | 0.36 | 0.25 | 0.28 | 0.28 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.28: DD estimations of the effect on age and education, matched ZRU as control group

| | All | New residents | New residents from other municipalities | New residents from the same municipality |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | | | Age | |
| ZFU1G × post97 | 1.484 | 0.898 | −0.479 | 1.753 |
| | (0.963) | (1.547) | (2.210) | (1.652) |
| ZFU1G × post2002 | 1.793 | 0.165 | −0.854 | 0.983 |
| | (1.182) | (1.706) | (2.420) | (2.009) |
| obs. (sampling areas × year) | 1119 | 581 | 395 | 458 |
| $R^2$ | 0.18 | 0.26 | 0.40 | 0.26 |
| | | | Share of 15-25 year olds | |
| ZFU1G × post97 | −0.038 | −0.043 | −0.020 | −0.066 |
| | (0.035) | (0.087) | (0.132) | (0.076) |
| ZFU1G × post2002 | −0.032 | −0.002 | −0.003 | 0.025 |
| | (0.043) | (0.095) | (0.132) | (0.090) |
| obs. (sampling areas × year) | 1119 | 581 | 395 | 458 |
| $R^2$ | 0.19 | 0.28 | 0.48 | 0.26 |
| | | | Share with a high degree | |
| ZFU1G × post97 | 0.011 | 0.129* | 0.072 | 0.166** |
| | (0.029) | (0.074) | (0.118) | (0.074) |
| ZFU1G × post2002 | 0.013 | −0.010 | 0.152 | −0.110 |
| | (0.037) | (0.082) | (0.139) | (0.105) |
| obs. (sampling areas × year) | 1117 | 562 | 348 | 443 |
| $R^2$ | 0.18 | 0.22 | 0.27 | 0.26 |
| | | | Share with a medium degree | |
| ZFU1G × post97 | −0.048 | −0.064 | −0.080 | −0.048 |
| | (0.034) | (0.063) | (0.107) | (0.079) |
| ZFU1G × post2002 | 0.053 | −0.020 | −0.065 | 0.052 |
| | (0.037) | (0.076) | (0.199) | (0.092) |
| obs. (sampling areas × year) | 1117 | 562 | 348 | 443 |
| $R^2$ | 0.31 | 0.20 | 0.23 | 0.27 |
| | | | Share with a low degree | |
| ZFU1G × post97 | 0.037 | −0.065 | 0.009 | −0.118 |
| | (0.047) | (0.076) | (0.113) | (0.094) |
| ZFU1G × post2002 | −0.066 | 0.030 | −0.087 | 0.058 |
| | (0.057) | (0.096) | (0.197) | (0.108) |
| obs. (sampling areas × year) | 1117 | 562 | 348 | 443 |
| $R^2$ | 0.32 | 0.25 | 0.30 | 0.29 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | no | no | no |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.

Table 1.29: DD estimations for job characteristics, 1993-2003

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | share among 26-65 years old of private sector high-skilled jobs | | | |
| ZFU1G × post97 | $0.029^{***}$ | $0.019^{**}$ | 0.007 | 0.008 |
| | (0.011) | (0.008) | (0.007) | (0.006) |
| ZFU1G × post2002 | | | $0.036^{**}$ | $0.019^{*}$ |
| | | | (0.016) | (0.011) |
| obs. (sampling areas × year) | 1530 | 1530 | 1530 | 1530 |
| $R^2$ | 0.293 | 0.494 | 0.303 | 0.497 |
| | share among 26-65 years old of private sector medium-skilled jobs | | | |
| ZFU1G × post97 | $0.040^{***}$ | $0.032^{***}$ | 0.017 | 0.017 |
| | (0.012) | (0.011) | (0.012) | (0.012) |
| ZFU1G × post2002 | | | $0.037^{**}$ | $0.026^{*}$ |
| | | | (0.017) | (0.014) |
| obs. (sampling areas × year) | 1530 | 1530 | 1530 | 1530 |
| $R^2$ | 0.311 | 0.444 | 0.317 | 0.447 |
| | share among 26-65 years old of private sector low-skilled jobs | | | |
| ZFU1G × post97 | −0.025 | 0.014 | 0.004 | 0.020 |
| | (0.025) | (0.021) | (0.023) | (0.020) |
| 32ZFU1G × post2002 | | | −0.048 | −0.010 |
| | | | (0.031) | (0.025) |
| obs. (sampling areas × year) | 1530 | 1530 | 1530 | 1530 |
| $R^2$ | 0.364 | 0.514 | 0.366 | 0.514 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2003, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

High-skilled occupations correspond to number 3 in the French socio-economic ranking, for medium-skilled occupations, it is 4, for employees 5 and for workers 6.
Long term contracts : undetermined duration (CDI) or at least than 12 months. Short term contracts : duration inferior to 12 months.

Table 1.30: DD estimations for job characteristics, 1993-2011

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | share among 26-65 years old of private sector high-skilled jobs | | | |
| ZFU1G × post97 | $0.021^{***}$ | $0.007$ | $0.009$ | $0.006$ |
| | $(0.008)$ | $(0.006)$ | $(0.007)$ | $(0.006)$ |
| ZFU1G × post2002 | | | $0.015^{*}$ | $0.001$ |
| | | | $(0.008)$ | $(0.006)$ |
| obs. (sampling areas × year) | 4208 | 4208 | 4208 | 4208 |
| $R^2$ | 0.196 | 0.376 | 0.197 | 0.376 |
| | share among 26-65 years old of private sector medium-skilled jobs | | | |
| ZFU1G × post97 | $0.037^{***}$ | $0.024^{**}$ | $0.018$ | $0.016$ |
| | $(0.011)$ | $(0.010)$ | $(0.012)$ | $(0.011)$ |
| ZFU1G × post2002 | | | $0.023$ | $0.009$ |
| | | | $(0.014)$ | $(0.012)$ |
| obs. (sampling areas × year) | 4208 | 4208 | 4208 | 4208 |
| $R^2$ | 0.186 | 0.325 | 0.186 | 0.325 |
| | share among 26-65 years old of private sector low-skilled jobs | | | |
| ZFU1G × post97 | $-0.027$ | $0.008$ | $0.001$ | $0.010$ |
| | $(0.024)$ | $(0.021)$ | $(0.025)$ | $(0.022)$ |
| ZFU1G × post2002 | | | $-0.035$ | $-0.003$ |
| | | | $(0.024)$ | $(0.021)$ |
| obs. (sampling areas × year) | 4208 | 4208 | 4208 | 4208 |
| $R^2$ | 0.193 | 0.319 | 0.194 | 0.319 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2011, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

Table 1.31: DD estimations for job characteristics, all ZRU as control group

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | share among 26-65 years old of private sector high-skilled jobs | | | |
| ZFU1G × post97 | $0.030^{***}$ | $0.014^{**}$ | $0.012^{*}$ | $0.010^{*}$ |
| | (0.008) | (0.006) | (0.006) | (0.005) |
| ZFU1G × post2002 | | | $0.027^{**}$ | 0.006 |
| | | | (0.011) | (0.008) |
| obs. (sampling areas × year) | 3108 | 3108 | 3108 | 3108 |
| $R^2$ | 0.211 | 0.448 | 0.214 | 0.448 |
| | share among 26-65 years old of private sector medium-skilled jobs | | | |
| ZFU1G × post97 | $0.040^{***}$ | $0.024^{**}$ | $0.021^{*}$ | $0.019^{**}$ |
| | (0.011) | (0.009) | (0.011) | (0.009) |
| ZFU1G × post2002 | | | $0.027^{*}$ | 0.007 |
| | | | (0.016) | (0.013) |
| obs. (sampling areas × year) | 3108 | 3108 | 3108 | 3108 |
| $R^2$ | 0.192 | 0.339 | 0.193 | 0.339 |
| | share among 26-65 years old of private sector low-skilled jobs | | | |
| ZFU1G × post97 | −0.026 | 0.006 | −0.009 | 0.003 |
| | (0.025) | (0.022) | (0.023) | (0.021) |
| ZFU1G × post2002 | | | −0.025 | 0.004 |
| | | | (0.026) | (0.023) |
| obs. (sampling areas × year) | 3108 | 3108 | 3108 | 3108 |
| $R^2$ | 0.247 | 0.371 | 0.247 | 0.371 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

Table 1.32: DD estimations for job characteristics, matched ZRU as control group

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| 1117 | | | | |
| | share among 26-65 years old of private sector high-skilled jobs | | | |
| ZFU1G × post97 | 0.013 | 0.006 | 0.006 | 0.004 |
| | (0.013) | (0.010) | (0.011) | (0.009) |
| ZFU1G × post2002 | | | 0.010 | 0.002 |
| | | | (0.014) | (0.012) |
| obs. (sampling areas × year) | 1117 | 1117 | 1117 | 1117 |
| $R^2$ | 0.127 | 0.475 | 0.127 | 0.475 |
| | share among 26-65 years old of private sector medium-skilled jobs | | | |
| ZFU1G × post97 | 0.034** | 0.023 | 0.009 | 0.006 |
| | (0.016) | (0.015) | (0.015) | (0.016) |
| ZFU1G × post2002 | | | 0.036** | 0.025 |
| | | | (0.017) | (0.017) |
| obs. (sampling areas × year) | 1117 | 1117 | 1117 | 1117 |
| $R^2$ | 0.172 | 0.343 | 0.174 | 0.344 |
| | share among 26-65 years old of private sector low-skilled jobs | | | |
| ZFU1G × post97 | −0.002 | 0.034 | −0.045 | −0.040 |
| | (0.035) | (0.032) | (0.038) | (0.033) |
| ZFU1G × post2002 | | | 0.062 | 0.106*** |
| | | | (0.037) | (0.033) |
| obs. (sampling areas × year) | 1117 | 1117 | 1117 | 1117 |
| $R^2$ | 0.199 | 0.436 | 0.201 | 0.442 |
| year fixed effects | yes | yes | yes | yes |
| UU fixed effects | yes | yes | yes | yes |
| Control variables | no | yes | no | yes |

Source : French Labor Force Survey, 1993-2007, 15-65 year old

*** significant at 1%. ** significant at 5%. * significant at 10%. Estimations with sampling weights. The number of observations can be slightly different when studying subpopulation : for example when computing unemployment rate, some areas may have only people out of the labor force and are therefore not used.
Control variables : gender, age, $age^2$, level of education divided in high, medium and low degrees, foreigners from outside EEC.

# Chapter 2

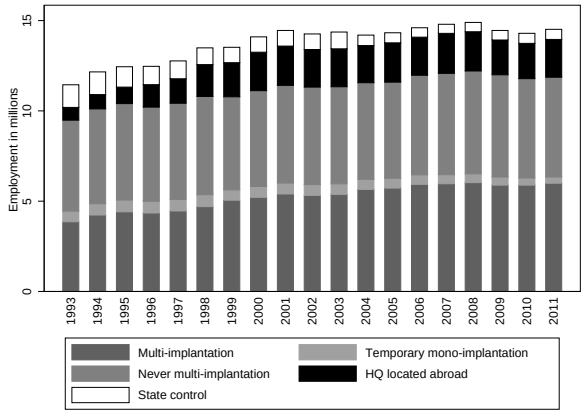
# Communication costs and the internal organization of multi-plant businesses : evidence from the impact of the French High-Speed Rail

# Introduction[1]

Large corporations with multiple sites represent a disproportionate fraction of employment. Figure 2.1 shows for example that in France, geographically dispersed corporate groups account for around 40% (6 million workers in 2011) of total employment in the for-profit sector (excluding workers directly hired by households), and even more when taking account of groups headquartered from abroad. The splitting and implantation decisions of such corporations has been the object of study of a large literature in economic geography (e.g. Aarland et al., 2007, Davis and Henderson, 2008, Henderson and Ono, 2008, Strauss-Kahn and Vives, 2009) and in trade (see the recent survey in Antràs and Yeaple, 2014). Yet, very little is known about the way these business organizations are managed. In this paper, we contribute to fill this gap and provide detailed evidence about the managerial costs of geographic dispersion.

Figure 2.1: The Prevalence of geographically dispersed corporate groups

*Break-down of total employment in the for-profit sector, by type of business organization*




Sources: Matched DADS files and LIFI survey, covering the for-profit sector (except agricultural activities and workers of the personnel service industries directly employed by households). See section 2.2 for further details.
Note: Employment is measured in terms of days of work, normalized by 360 (to be comparable with headcounts).

Our empirical investigation is guided by theoretical predictions. The literature in corporate finance (Giroud, 2013, Giroud and Mueller, 2015) suggests that the geographical dispersion of a group's affiliates might hamper information transmission and monitoring by the managers of the group's headquarters, thus amplifying moral hazard problems; it predicts that such a mechanism could negatively affect affiliate size. The literature in economic geography (Duranton and Puga, 2005) further suggests that the geographical dispersion of affiliates in a corporate group is related to the optimal mix of "functions" present in each implantation. A prediction of

[1]This chapter is based on a joint work with C. Lelarge and C. Trevien.

this strand of the literature is therefore that a reduction in communication costs between headquarters and affiliates lowers the cost of transferring headquarters services to remote affiliates, thus increasing the incentives to specialize affiliates by function. Last, the literature in organizational economics (Garicano, 2000, Garicano and Rossi-Hansberg, 2006, 2012, Antràs et al., 2006, 2008) predicts that workers are differentially impacted by decreases in internal communication costs, depending on their skills. A robust prediction of this set of papers is that the need for skills at the bottom of the hierarchies decreases, such that wages of the less skilled workers (and the associated labor costs) decrease.[2]

We test these predictions using administrative data providing a comprehensive description of the workforce in the entire population of French corporate groups. We take advantage of the expansion of the French high-speed rail network over the 1993 to 2011 period and interpret the associated decreases in travel times as decreases in internal communication costs for corporate groups benefiting from the new high-speed rail services.[3]

Our regressions show that a functional specialization indeed occurred and was most pronounced in the service industries, where information to be transmitted is arguably softer (Petersen and Rajan, 2002). We also obtain that employment of affiliates in manufacturing industries, retail and trade and business services was positively affected by decreases of their travel time to headquarter. These results are robust to alternative identification strategies addressing the problem of the endogenous placement of the HSR infrastructure (use of high-dimensional fixed effects controlling for local and affiliate-level shocks as in Giroud, 2013 and evidence from un-realized lines as in Donaldson, 2014). At the group level, our regressions suggest a positive impact on the operational profit margin consistent with the hypothesis that travel time between affiliates and headquarters is a managerial cost for geographically dispersed corporate groups.

These meaningful patterns of adjustments in the internal organization of corporate groups

[2]See Bassanini et al. (2015) and Landier et al. (2007) for an analysis of labor adjustments on the extensive margin (dismissals) depending on the distance to headquarters.

[3]Our paper is therefore related to the large literature (Michaels, 2008, Datta, 2012, Banerjee et al., 2012, Donaldson, 2014, Faber, 2014, Ghani et al., 2015) investigating the economic economic impact of standard rail or road infrastructure on various dimensions of firm activities: the global volume of trade, the management of inventories, access to remote suppliers or markets (Bernard et al., 2015, Nunn, 2007, Cristea, 2011). However, in these contributions, infrastructures are mainly understood as facilitating "the juncture between production and consumption" (Martin and Rogers, 1995): they essentially generate a reduction in trade barriers which pertains mainly to the circulation of *goods* (Donaldson and Hornbeck, 2015), with the associated impact in terms of increases in trade-related activities, selection, and aggregate productivity (Melitz, 2003). However, these effects are unlikely to be of first order in the case of high-speed rail, because this mean of transportation pertains mainly to *people*, and not to goods. In the case of the French High Speed Rail program, most of the infrastructure is not even accessible to freight (at the notable exception of mail) because technically, HSR tracks are too steep for the weight of freight trains.

suggest that face-to-face interactions remain crucial in spite of the development of other means of communication (phone, e-mail, visio-conference) over the same period (Storper and Venables, 2004). Our results also show by revealed preference that business travellers (or their employers) are willing to pay a significant premium for reduced travel time, in spite of the arguably high comfort and "workability" of HSR coaches.

The remainder of the article is organized as follows. Section 2.1 proposes a synthesis of theoretical predictions. In section 2.2, we describe the French HSR network and present the datasources which enable us to provide a comprehensive picture of French corporate groups. The empirical strategy is explained in section 2.3. Regressions results are discussed in section 2.4. Robustness checks are performed in section 2.5 and complementary descriptive evidence is proposed in section 2.6.

## 2.1 The management of multi-plant businesses : a review of theoretical predictions

In this section, we review three different but non mutually exclusive strands of the literature analyzing how travel times between headquarters and affiliates of corporate groups are likely to affect their managerial organization (and performance). In each case, their testable empirical predictions are outlined.

### 2.1.1 Geographical dispersion and affiliate size

A recent literature in corporate finance (Giroud, 2013, Giroud and Mueller, 2015) relates travel times to information transmission between headquarters and affiliates in settings where there are information asymmetries and moral hazard problems. It delivers predictions linking travel times and investment or employment at the affiliate level.

These contributions specifically focus on the dual managerial structure of corporate groups, with both managers at headquarters ("principals"), who are endowed with the ultimate decision rights, and managers at remote affiliates ("agents") who have an informational advantage over managers at headquarters about the profitability of local investment projects. The management of such business organizations features a moral hazard problem if the interests of managers at affiliates are not fully aligned with the interests of managers at headquarters, with the associated agency rents captured by the managers of remote affiliates and reduced profit for the group as a whole. Whether local managers over-invest (over-hire) or under-invest (under-hire) depends on

whether managers at affiliates have preferences for local "empire building" strategies, or conversely if they preferred an excessively "quiet life". Bertrand and Mullainathan (2003) actually show that the second case is more frequent among US managers, which implies that managers at affiliates are likely to under-invest when investment decisions are delegated to them. In such a setting, lower travel times between headquarters and remote affiliates increase monitoring and are therefore associated with higher investment (Giroud, 2013) and higher complementary employment (Giroud and Mueller, 2015) at affiliates.[4]

To test the relevance of such mechanisms in the French data, we replicate the analyzes in Giroud (2013) and Giroud and Mueller (2015) and investigate the relationship between employment at affiliates and travel time to their headquarters.[5] As in Giroud (2013), we also investigate the correlation between travel time and affiliate destruction or creation: indeed, if proximity facilitates monitoring and information gathering, one might expect that it also matters on the "extensive margin".

### 2.1.2 Geographical dispersion and the functional specialization of affiliates

The literature in economic geography suggests that the geographical dispersion of affiliates in a corporate group is related to the optimal mix of "functions" present in each implantation. In Duranton and Puga (2005), firms are considered as bundles of two broad types of functions: "headquarter services" on one hand, and production activities on the other hand. These two functions can be either pooled in the same location or split into different plants. Splitting is costly, for example because of the agency problems outlined in the section 2.1.1.[6] However, there are gains to split firms when there exist "function specific" agglomeration economies, such as the possibility to outsource certain activities to local suppliers that might be specifically

[4]This reasoning assumes that investment decisions for affiliates are delegated to local managers. This needs not be the case (see section 2.1.2) but the same prediction holds (in expectation) under centralized control at headquarters when HQ managers are risk averse: easier information acquisition about the profitability of investment projects at remote affiliates decreases the "uncertainty premium" required by them and increases average investment.

[5]Unfortunately, our data do not enable us to observe investment at the affiliate level, such that for this variable, we will only be able to estimate regressions aggregated across all affiliates, at the group level.

[6] Duranton and Puga (2005) model such mechanisms in a reduced form, as a fraction of managers' time that is lost in travels to visit the remote affiliate. Refer to Acemoglu et al. (2007) for a more detailed description of the trade-offs involved: the optimal organizational choice between delegation of authority to a local manager or centralized decision taking at headquarters trades off the gain to rely the local manager's superior information against the risk that he could use his informational advantage to make choices that are not in the best interest of the group as a whole. Shorter travel times ease information acquisition by principals, and shift the trade-off in favor of centralized control at headquarters.

appropriate, the optimization of labor costs across local labor markets (depending on local labor supply), or simply market access for final products.

The distinctive prediction of Duranton and Puga (2005) is that a reduction in travel time lowers the cost of transferring headquarter services to remote affiliates, thus increasing the incentives to specialize affiliates by function.[7] We therefore expect them to be relatively more focused on their production activities and to discard the administrative tasks which are cheaper to complete at headquarters. This prediction can be tested by regressing the share of employment at affiliates that is devoted to production activities (as opposed to managerial, administrative activities) against travel time between affiliates and headquarters: we expect the sign of the corresponding coefficient to be negative.

### 2.1.3 Geographical dispersion and wages at affiliates

The literature in organizational economics (Garicano, 2000, Garicano and Rossi-Hansberg, 2006, 2012, Antràs et al., 2006, 2008) enables to make predictions about the way heterogeneous workers (in terms of skills) might be differentially impacted by decreases in internal communication costs within a same group, labelled here as "firm" (like in the expression "theory of the firm"). In this strand of the literature, the internal organization of production (i.e., the way workers of different skills and knowledge are organized) is endogenously determined by the optimization of the usage of these two costly inputs of production. Firms organize as hierarchies because these types of organizations allow for the most parsimonious usage of two costly inputs of production: workers' time and workers' knowledge. In such structures, the bottom layer is specialized in the most common problems and concentrates the less skilled workers, while the upper layers only deal with exceptions (Garicano, 2000). Managers in one layer spend their time communicating with less skilled agents in the layer just below and solving some of the problems that are transmitted to them. They pass the rest to the layer with more skilled agents just above them.

The previous baseline representation of firms is plugged into a two - region model in Antràs et al. (2006) and Antràs et al. (2008), which can easily be transposed to our setting. As in section 2.1.2, lower travel times, i.e. decreases in communication costs between units located in

[7] Notice that in Duranton and Puga (2005), this result is an equilibrium outcome: a decrease in the cost of remote management (if sufficiently large) shifts the entire economy from an equilibrium where no firm is geographically dispersed and cities specialize by sector, to an equilibrium where all firms adopt a multi-location organizational form and cities specialize by function. The authors suggest that a "smoother" result would hold in an augmented version of the model incorporating some firm level heterogeneity, together with (sufficiently large) sunk costs of reorganization. Such additional dimensions of firm heterogeneity would explain why all firms would not split instantaneously and relocate all of their units along the new HSR lines as they open.

different regions, always increase the relative benefit to split businesses in order to take advantage of lower relative wages in the less dense areas; it also has a positive impact on overall group size. A more distinctive prediction of these papers is that lower communication costs increase the incentives to organize in more complex hierarchical organizations (having more layers) by making them a better "technology" to economize on knowledge. As a result, the relative role of managers at headquarters increases, while it is profitable to decrease the knowledge content of bottom operational workers at affiliates (and therefore, their skills), in order to save on their wage. We test this prediction by regressing the wage of low-skill operational workers on travel time, and expect a positive sign for this coefficient.[8]

### 2.1.4 Geographical dispersion and operational profit at the group level

Notice that in all models of sections 2.1.2 to 2.1.3, decreases in travel time between headquarters and affiliates always decrease the overall costs of operating large, multi-plant businesses. At the group level, we therefore expect a negative correlation (other things equal) between the operating profit margin and average travel time to affiliates. Corporate groups which are cheaper to operate grow larger, other things equal: we therefore also expect a negative correlation between overall group size and average travel time to affiliates.

## 2.2 Data

### 2.2.1 The geographical organization of corporate groups

The first ingredient of our analysis is the information system allowing us to recover the structures of French corporate groups. We rely on the LIFI[9] files and use the information on the (direct and indirect) equity stakes of headquarters in affiliate companies reported in this data source. Prior to 1999, the LIFI files only covered companies of the private sector whose size was above at least one of three different thresholds, defined in terms of financial stakes in other firms (higher than 1.2 million euros), sales (60 million euros) or employment (500 workers). From 1999 onwards, these files are complemented with the Diane-Amadeus (Bureau Van Dijk)

[8]Section 2.1.1 also generates predictions related to wages. In this set-up, a decrease in communication costs would alter the wage contracts of managers at affiliates from rather high- to rather low- powered incentive contracts. Unfortunately, we are not able to test this prediction with our data.

[9]The acronym "LIFI" stands for "LIaisons FInancières" (financial linkages). See e.g. Boutin et al. (2013) for a previous use of this dataset. Complementary exhaustive fiscal data (BRN files, also used in Boutin et al., 2013) provide the accounting information required in our empirical analysis.

dataset, which is constructed from commercial court records and which covers smaller business groups. For most of our period of analysis, our file therefore contains almost exhaustive information about corporate groups operating in France.

We follow the standard approach in corporate finance since the classic contribution by La Porta et al. (1999) and define headquarters of (potentially complex) group structure as units having the actual ultimate control over assets in the group, thanks to the direct or indirect ownership of more than half of the equity in any of the group affiliates. We locate these headquarters at the main plant of the group headquarter (ultimate owner) company;[10] affiliates correspond to all other plants of the considered group. However, previous empirical work (e.g. Aubert and Sillard, 2005, Picart, 2004) has documented that establishments (and even companies within groups) might be created, terminated and replaced for reasons that are uncorrelated with the human resource management practices we want to focus on[11]. We choose to abstract from such phenomena by aggregating the information across all plants of a same group, having the same activity (at the 1 digit level) and located in the same municipality ("commune") into a single "affiliate" unit.[12]

This dataset allow us to complement figure 2.1 in the introductory part and provide in figure 2.2 a synthetic description of the geography of remote control, as of 2011. We use as our unit of local markets the commuting zones which are constructed "as the geographical areas within which most of the labor force lives and works, and in which establishments hire most of their workforce". By definition, if headquarters and affiliates are not located in the same commuting zone, travel from one to another by managers cannot be considered as a local trip. Panel (A) provides for each commuting zone, the share of businesses that are controlled from outside. This share is higher than 15% in most commuting zones, and above 20% in a number of zones located in the northern half of the country, which is explained by the disproportionate "sphere of corporate influence" of Paris over this part of the country.[13] The employment weighted version

[10] In cases where these headquarters are non-employer holdings, we rather choose the employer company that is most directly related to the holding, in terms of rank of control, and in cases where several companies meet this criterion, we select those having the largest share of executives (see section 2.2.2 below). The aim of this procedure is to locate (probabilistically) the upper management team of the entire group structure.

[11] In particular, plants are terminated and created even when transfers occur on very short distances, e.g. for reasons related to capacity, which we want to abstract from. Moreover, firm and plant identifiers also change when the legal status of companies evolves, most often due to regulatory constraints (e.g. upper bounds on the admissible number of shareholders for certain legal forms, *etc.*) or due to fiscal or administrative reasons which, again, are entirely orthogonal to the mechanisms described in section 2.1.

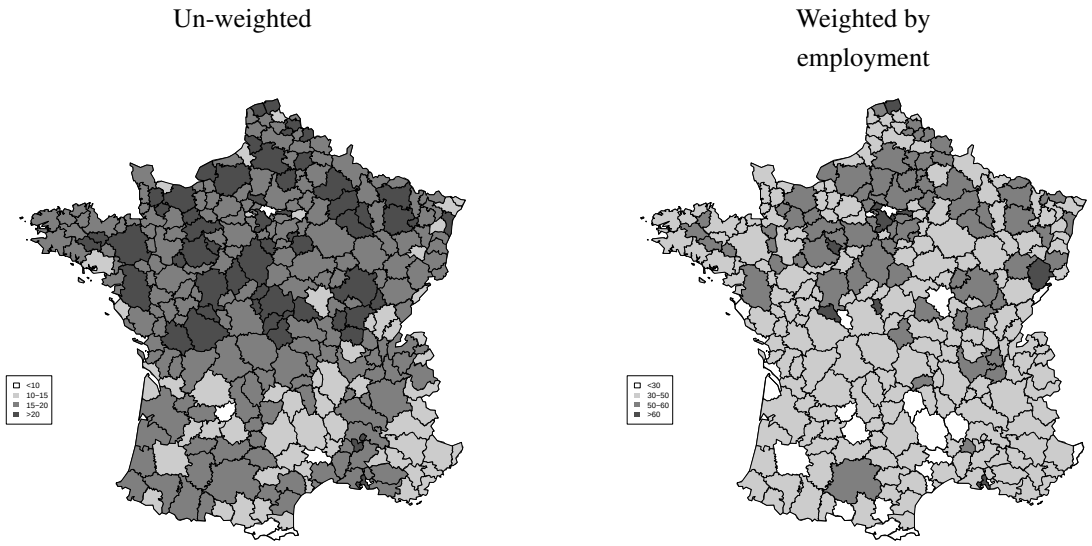
[12] This aggregation is not drastic, since there are ca. 36,000 such municipalities across France. Its benefit is to increase by a little bit the power of our setting by increasing the number of years an affiliate unit is observed - 3.2 years on average. Notice also that the variations of travel time induced by HSR line openings are homogenous within municipalities, since they are typically served by only one single station.

[13] See appendix 2.F for a comparison of the "spheres of corporate influence" of different French cities showing the disproportionate weight of Paris.

of the indicator presented in panel (B) shows that in most of the country, more than 30% of employment is managed at arm's length. This share rises to rates above 50% in a significant number of commuting zones, mostly located in the northern part of the country.

Figure 2.2: Share of affiliates under control of a HQ located outside the considered commuting zone

*Percentages for the year 2011*




Sources: Matched DADS files and LIFI survey, covering the for-profit sector (except agricultural activities and workers of the personnel service industries directly employed by households).
Notes: The left panel describes the number of affiliates in each commuting zone that are controlled by HQs located outside the zone, as a share of the total number of businesses (affiliates and HQs) located in each zone. The right panel describes the share of private employment in each commuting zone that is under control of an external HQ: this indicator is an employment weighted version of the previous.

### 2.2.2 The organization of the workforce within corporate groups

We complement the previous files with exhaustive worker level information sourced from the DADS[14] files. These files are available from 1993 onwards, and include roughly 14 million workers per year in the recent period. They allow us to track economically active plants within each group and provide us with a rich description of their internal workforce and wage structure.

Most importantly, the classification of occupations in the DADS files allows us to contrast the workforce allocated to production activities with the workforce allocated to support and administrative activities, both at headquarters and affiliates. This distinction is required to test the

[14]The acronym "DADS" stands for "Déclarations Annuelles de Données Sociales". See e.g. Caliendo et al. (2015) for a previous use of these files.

empirical predictions of section 2.1.2. We interact this typology of functions with the indicators of hierarchical layers proposed in Caliendo et al. (2015), in order to test the predictions of section 2.1.3, which rely on these concepts:

- *Administrative functions:*[15]
  - Low-skilled workers performing administrative tasks,
  - Medium-skilled workers performing administrative or commercial tasks,
  - High-skilled workers performing administrative or commercial tasks: this category will be labeled as "managers" in the remainder of the article.
- *Production functions:*[16]
  - Low-skilled workers having functions related to production or performing commercial tasks,[17]
  - Medium-skilled workers having functions related to production,
  - High-skilled workers having functions related to production.

Figure 2.3 describes the average structure of the workforce we obtain when implementing the above definitions, both at affiliates and headquarters.[18] Notice first that methodological changes in the coding of occupations occurred in 2002 and 2009 and produced two breaks in the series.[19] Abstracting from this difficulty, panel (A) of figure 2.3 shows that administrative functions represent a similar share of the workforce, on average, at headquarters and affiliates. What differentiates HQs from affiliates sharply is not the weight of these activities, but the structure of skills *within* them: headquarters employ 15 to 20% of their workforce in higher management positions, against 5 to 10% in the case of affiliates. Conversely, affiliates employ around twice as many middle managers (ca. 20%) as headquarters. Last and in contrast, the structure of the workforce allocated to production activities (panel B in figure 2.3) is not highly contrasted between headquarters and affiliates: headquarters only tend to hire somewhat fewer low-skilled and medium-skilled workers, and more high-skilled workers. Unreported

[15] See appendix 2.C for a full description of the classification of occupations. In the typology which follows, low-skilled administrative workers are coded 5 except 53, 55 and 56. Medium-skilled administrative workers are coded 4 except 47 and 48. High-skilled administrative workers are coded 2 and 3 except 34 and 38.

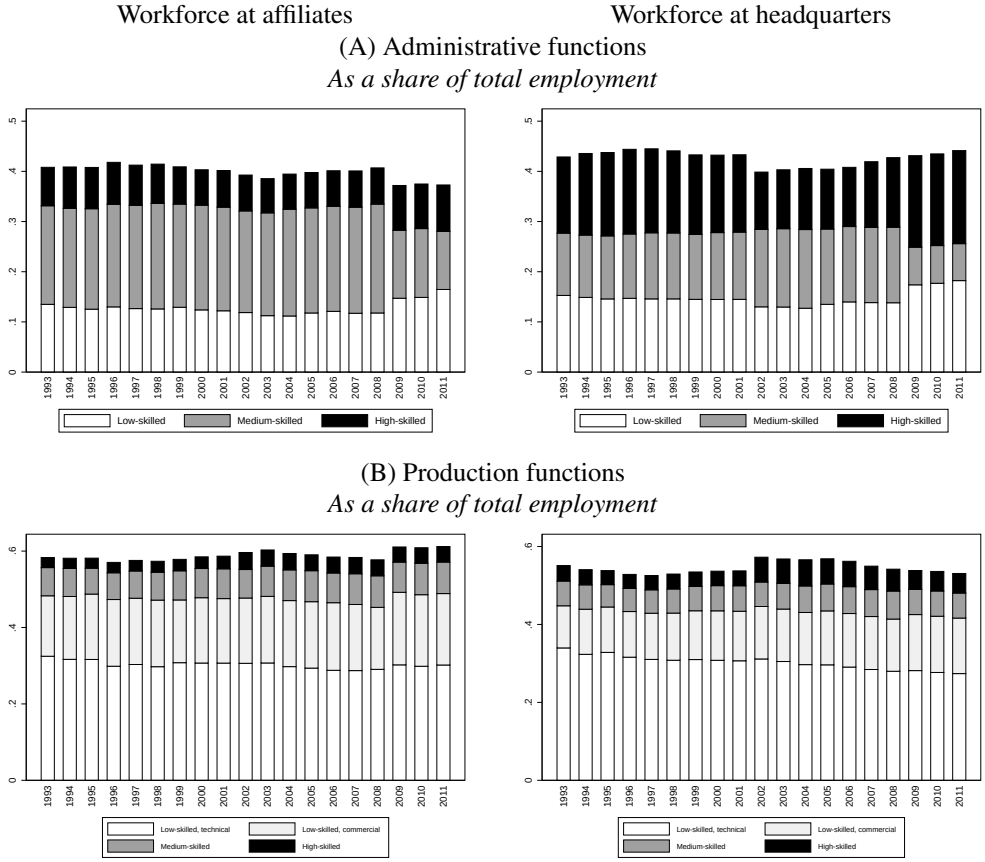
[16] Low-skilled production workers are coded 6 and 53, 55 and 56. Medium-skilled production workers are coded 47 and 48. High-skilled production workers are coded 34 and 38.

[17] Notice that we allocate commercial low-skilled workers to production activities, which is of particular relevance in the retail and trade industries. For medium and high-skilled workers, unfortunately, the classification available in our file does not allow to distinguish between administrative and commercial activities.

[18] In these graphics, employment in each occupation is measured in days (between start and end of the labor contract of each worker) to take part time work into account.

[19] Our empirical strategy, which saturates each regressions with rich temporal fixed effects, is relatively immune to this measurement issue (see section 2.3).

Figure 2.3: Structure of the Workforce at Affiliates vs. Headquarters, 1993 - 2011




Sources: Matched DADS files and LIFI survey; units which are part of geographically dispersed groups.
Notes: Employment is measured in days. The break in the series in 2009 was generated by a change in the codification procedure for occupations in the DADS files. It affects mostly the breakdown between low-skilled administrative or commercial occupations, and medium-skilled administrative occupations.

complementary descriptive statistics confirm unsurprisingly that the structure of the workforce at affiliates is highly differentiated across industries. For example, skilled workers (involved in either administrative or production functions) represent 11% of the workforce in manufacturing industries, 21% in business services and 18% in the finance industry. In contrast, the share ranges between 6 and 8% in the personnel services, retail and trade, or transport industries. The share of managers (high-skill administrative workers) is around 4% in all industries, except in the business services (10%) and finance (18%) industries: in these two cases, most probably part of them are in fact allocated to production (but non "technical") activities.

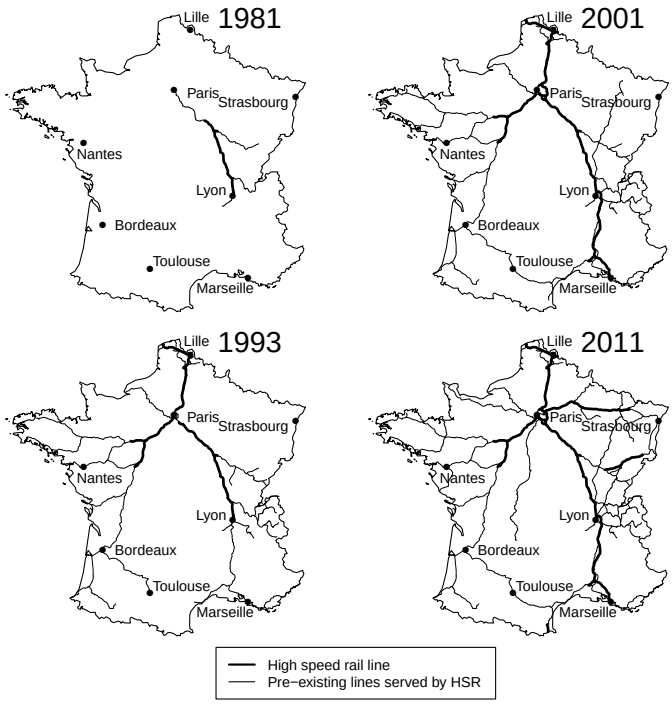
### 2.2.3 HSR network and rail travel times

The last ingredient for our empirical analysis is detailed information about the evolution of the rail network over time. This allows us to compute rail travel times between any two points of the French metropolitan territory - and more specifically, between the headquarters and affiliates of French corporate groups. We collected detailed information from the archives of the French national rail company or its open-data platform, and complemented with various technical publications available from rail fan web sites to reconstruct the expansion of the HSR network over time. The outcome of this task is represented on figure 2.4, which describes the expansion of the HSR network over thirty years: the first HSR line was opened in 1981 on a segment located on the track between the two largest cities, Paris and Lyon. This line was subsequently extended in 1994 and 2001 to ultimately reach Marseille on the Mediterranean Coast. The network was also extended towards the Atlantic coast in 1989-1990, towards Lille and London in 1993 and 1994, and towards Strasbourg and Frankfurt (in Germany) in 2007[20].

The expansion of the HSR network had a huge impact on rail travel times across the territory because high-speed trains operate at twice the maximum standard rail speed: ca. 320km/h on the dedicated infrastructure. While the actual procedure we implemented to compute rail travel times is relegated to appendix 2.D, figure 2.5 shows how the expansion of the HSR network translated into reductions in travel times for selected destinations over our period of analysis. Between 1993 and 2011, new line openings mainly benefited the Eastern and Southern regions, which experienced the largest accessibility gains, both in terms of time and geographical range. Paris experienced the symmetric gains towards the Mediterranean zone and the Eastern zone. A few examples enable to gauge orders of magnitude: rail travel time between Marseille and Paris decreased from 6h40 to 4h40 in 1982, to 4h18 in 1994 and ultimately to 3h00 in 2001. Between

[20]As of today, high-speed rail service also includes cross-border services to UK, Belgium, Netherlands, Germany, Switzerland, Italy and Spain. However, this feature of the network in not analyzed in the present paper, since we are not able to locate HQs abroad.

Figure 2.4: Evolution of the French HSR Network between 1981 (resp. 1993) and 2011




Sources: Archives and open-data platform of the French national rail company; rail fan web sites. Authors' computations.

Strasbourg and Paris, travel time decreased from 3h55 to 2h20 in 2007, when the Eastern line opened.

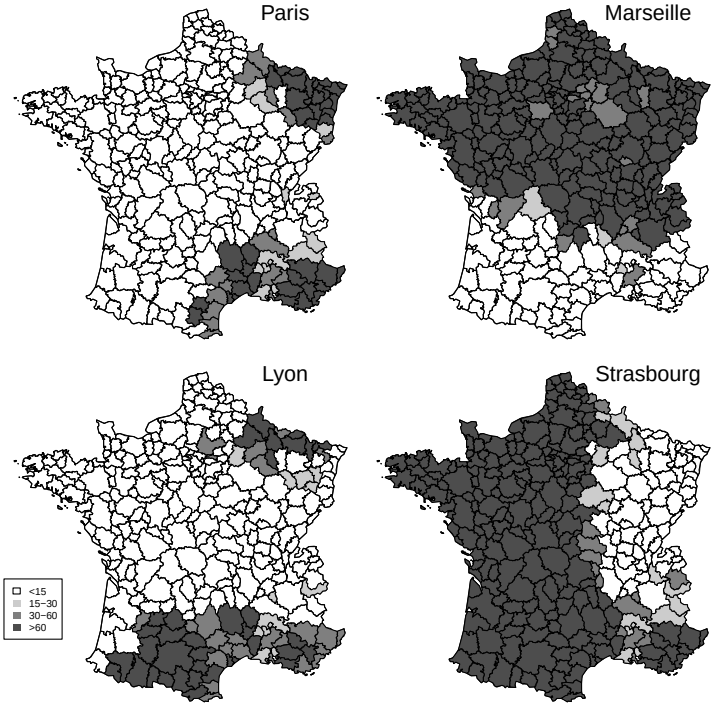
In our empirical analysis, all of the indicators of travel times between headquarters and affiliates are based on the above rail travel time computations, and all travel time variations (reductions) are driven by the opening or extension of new HSR lines. One important concern is of course that our indicator misses all travel time reductions which might be driven by other means of transportation - and more specifically, by airlines.[21] Appendix 2.A however shows that over our period of analysis, HSR became one of the most popular means of transportation for long distance travels, such that rail travel times became of practical relevance to managers. Appendix 2.A also shows that the airline industry did not seem to be a strong competitor of HSR over the same period, since it rather lost market shares in spite of the liberalization episode of the 90s. This is most presumably because travel time by air (incorporating access to airports, which in contrast to most train stations, are often located in the outskirts of cities) is not lower than rail travel time for most domestic trips.[22] In all cases, as also argued in detail in appendix 2.A,

[21] No heavy change is to be expected from road travels.

[22] See Behrens and Pels (2012) for a similar argument in the case of the London-Paris passenger market.

Figure 2.5: Reduction in Rail Travel Times to Selected Destinations

*in minutes, between 1993 and 2011*




Sources: Archives and open-data platform of the French national rail company; rail fan web sites. Authors' computations.

we expect our approximation to bias our regression results against finding any impact of travel time on management practices.

A second, more minor problem is that HSR line openings were almost always associated with improved rail service beyond travel time:[23] for example, new and more comfortable coaches were most of the time introduced, with increased "workability" and a higher frequency of train services, at least for terminal cities.[24] Conversely, the quality of service offered by standard rail might have suffered from the reallocation of resources of the rail company towards HSR. In our empirical analysis, such unobserved differential evolution of the rail services provided by HSR

[23]A related concern is that our results might be driven by standard market access mechanisms rather than by those described in section 2.1 if the new HSR infrastructure was accessible to freight and also impacted the transport of goods. This is however not the case of the dedicated HSR infrastructure, which is too fragile and sometimes too steep to be accessible to freight trains (because of their weight). Note furthermore that our empirical strategy would anyway address this potential concern (see sections 2.3.1 and 2.3.1).

[24]This last point is more debated for the case of certain smaller or middle size cities, more precisely those that are bypassed by HSR services while they were previously served by traditional rail service (FNAUT, 2011, Emangard and Beaucire, 1985). For example, the number of direct services per day from Paris to Charleville - Mézières fell from 7 to 3 in 2007, and from 9 to 4 between Paris and Tourcoing.

and standard rail (which is correlated with our indicator of travel time variation) would bias our estimates somewhat upwards.

## 2.3 Empirical strategy

### 2.3.1 Main specification at the affiliate level

Our main equations of interest are estimated at the affiliate level, and investigate the correlations between travel time and the outcome variables that are suggested in section 2.1. They take the following generic specification:

$$y_{ijlt} = \beta.T_{ijlt} + \varepsilon_{ijlt} \tag{2.1}$$

where subscript $i$ denotes the affiliate, $j$ its headquarters, $l$ denotes the commuting zone were the affiliate is located and $t$ denotes time. $T_{ijlt}$ denotes travel time between the affiliate and its headquarter and $y_{ijlt}$ is the outcome of interest: typically affiliate employment, the share of employment allocated to production activities ("production employment") or the wages of production workers.

#### Baseline identification strategy

We first insert affiliate level fixed effects $\alpha_{ijl}$ into this regression framework in order to address the fact that affiliate location (relative to its headquarters) is potentially endogenously driven by unobserved affiliate characteristics that are also correlated with the outcome variables. For example, a higher specificity of the production of the affiliate[25] might be correlated with both a higher proximity of the considered affiliate to its headquarters, and higher wages paid to its production workers. Thanks to the inclusion of this first set of fixed effects, the relation between travel time and the various outcome of interest will be identified by *changes* in travel time, namely those generated by the expansion of the HSR network over time. This is also ensured by the fact that a group of which the headquarter moves is also considered a new group and that an affiliate moving out of its commuting zone is considered as a new affiliate. In this framework, the extensive margin (openings and closures of affiliates) is not accounted

[25]Regressions are estimated industry by industry to further address this concern and to investigate industry level heterogeneity.

for but it is controlled by the affiliate level fixed effects. Some descriptive evidence on affiliates exits and entries is therefore proposed in section 2.6 as a complement.

However, this regression framework is still affected by the fact that the placement of the HSR infrastructure might be endogenous: there might exist some local unobserved heterogeneity, e.g. local growth potential, which could have been taken into account for the governmental decision to build the HSR infrastructure, and which might be also correlated with our outcome variables, thus biasing our results. Furthermore, the HSR infrastructure itself might have boosted local growth, a phenomenon we want to control for in our regressions. We address these two issues using an identification strategy similar to Giroud (2013) and Giroud and Mueller (2015), by introducing large sets of commuting zone $\times$ time "fixed" effects ($\alpha_{lt}$), on top of the standard affiliate level fixed effects ($\alpha_{ijl}$):

$$y_{ijlt} = \alpha_{ijl} + \alpha_{lt} + \beta.T_{ijt} + \gamma.X_{jt} + \varepsilon_{ijlt} \tag{2.2}$$

These many dummy variables capture the time varying *local* heterogeneity which could generate the above endogeneity issues. Notice that all of these fixed effects are identifiable in our setting, because the impact of variation in travel times on outcomes of interest is identified *jointly* from the locations of affiliates *and* from the location of their headquarters, i.e. travel time is a *dyadic* variable. More intuitively, our identification strategy amounts to use as a control group, the set of local affiliates located in the same commuting zone as the considered affiliate, which are therefore exposed to the same local shocks, but which are unaffected (or differently affected) by travel time reductions because of a different location of their headquarters[26].

One additional concern with such specifications which are saturated with fixed effects is that it requires that the explanatory variables of interest have to be measured accurately, since otherwise fixed effects tend to amplify the attenuation bias arising from measurement error.[27] We argue in appendix 2.D.3 that if travel times might be affected by some measurement problems, *variations* in travel times are likely to be measured much more accurately: since identification in equation 2.2 is in differences, this is what is required. Furthermore, this problem should if anything lead us to minimize the true impact of travel time on our outcome variables.

In terms of the estimation method, the inclusion of several sets of high-dimensional fixed

[26]In the reported regressions, we exclude affiliates which are not part of a multi-implantation group, mainly for practical reasons (this reduces drastically our file size and the associated computing time). However, these observations could serve as additional controls for local shocks. Un-reported regressions show that results are basically unaffected by this choice.

[27]This problem is well known in the literature about the estimation of production functions, where capital is typically not measured accurately (Griliches and Hausman, 1986).

effects renders estimation non-trivial, despite the fact that equation 2.2 is fully linear. We choose to apply the iterative procedure proposed by Guimaraes and Portugal (2010): its principle is to iterate on sets of normal equations that are conveniently defined; the only practical constraint is to use *continuous* empirical proxies for the explanatory variables of main interest, in order to insure identification (see appendix 2.B for full details).

**Robustness checks**

We also provide a bunch of robustness checks to test the robustness of our results to additional potential sources of endogeneity. First, additional controls for group level market conditions $X_{jt}$, both on the domestic and the international markets, are incorporated in all specifications to control for group-wide shocks which might be spuriously temporally correlated with travel time reductions in our sample. This strategy is however not sufficient in cases where group-wide shocks are *endogenously* correlated with HSR line openings: this would happen, for example, in cases where the group lobbied in favor of certain HSR line openings or extensions.[28] To mitigate this concern, we first estimate regressions where we simply remove the most "suspicious" observations, namely the largest affiliates in each area. Second, we experiment with specifications where we remove large HSR beneficiaries, i.e. affiliates benefiting from HSR for more than 50% of the rail track to their headquarters.[29]

**Further evidence from un-realized lines**

To mitigate an even broader set of endogeneity concerns, but at the cost of discarding a larger fraction of the sample, we also implement an additional strategy along the lines of Donaldson (2014). This strategy makes use of the fact that a governmental plan was drafted in 1991 (ahead of our period of analysis) and endorsed by the Prime Minister of the time, which described an ambitious network of HSR lines to be built in the years to come, based on local development and profitability criteria (Ministère de l'Équipement, 1991).[30] However, some of the lines were not implemented (Zembri, 1997). In some cases it was because their expected profitability was

[28] Giroud (2013) also considers the possibility of lobbying at the affiliate (rather than group) level. We think that this case is very unlikely for HSR given the cost of the infrastructure. However, the specifications suggested in the previous case, where we remove the largest affiliates or discard affiliates benefiting from HSR on a too large proportion of the track to their headquarters, would also mitigate the concern of lobbying at the affiliate level.

[29] This strategy is very similar to what is implemented in Giroud (2013), in specifications where he only considers indirect flights where either the last leg of the flight (involving the plant's home airport) or the first leg of the flight (involving headquarters' home airport) remains unchanged.

[30] See appendix 2.E for a map of the foreseen infrastructures.

deemed too low:[31] we choose to discard these lines. For the remainder, non-implementation was explained by the fact that budgetary constraints imposed some phasing and rescheduling of projects, or because of unexpected technical difficulties[32] that are arguably exogenous in our empirical setting.

We suggest that affiliates which would have benefited from the latter subset of the 1991 plan are likely to have the same un-observables (potentially correlated with travel time reductions) as affiliates which actually benefited from realized HSR lines. In more technical terms, this would imply that conditional on being part of the 1991 plan, travel time is orthogonal to the error term in equation 2.2.[33] We therefore propose to estimate our baseline specification on the corresponding sub-sample, after discarding affiliates which could never expect benefiting from the HSR technology because of their location relative to their headquarters. This is an even more flexible procedure than simply inserting the variable indicating insertion into the 1991 plan as a new control, as a strict implementation of the Donaldson (2014) methodology would imply.

### 2.3.2 Complementary specification at the group level

As explained in section 2.1.4, some important theoretical predictions hold at the group level rather than at the affiliate level, most notably predictions about the impact of reduction in travel time (managerial costs) on overall group size and profitability. We therefore run a few specifications on the level of the entire group:

$$y_{jt} = \alpha_j + \beta.T_{jt} + \sum_r \alpha_{rt}.\delta_{jrt} + \gamma.X_{jt} + \varepsilon_{jt} \tag{2.3}$$

As previously, we introduce group level fixed effects to control for fixed observable and unobservable characteristics that might be correlated to our variables of interest such as group size and profitability. Moreover, similarly to the specification at the affiliate level, the variations of the gross average travel time to affiliates $T_{jt}$ might be correlated to local dynamics of

[31] This is the case of lines connecting Paris to the center of the country (Auvergne, Limousin), or to Normandy, which all had expected profitability below 4%.

[32] In their case, expensive art works or deviations were required by local authorities or lobbyists to preserve the environment (e.g. protected areas, vineyards, *etc.*) - see Zembri (1997).

[33] Notice that this procedure is not strictly speaking an instrumental variable strategy. Indeed, we do not argue that the placement of the 1991 plan was more exogenous than the placement of the actually implemented network, as would have been required for an instrumental variable. We only suggest that the factors determining actual implementation (i.e. the mapping between the 1991 plan and the actually implemented network) are likely to be relatively orthogonal to our relation of interest, such that the information about insertion into the 1991 plan captures the unobserved heterogeneity potentially generating remaining endogeneity issues.

the zones where the group is operating. Hence, we insert a set of dummy variables $\alpha_{rt}$ capturing market conditions in the areas where the group operates. These dummy variables are not mutually exclusive, such that it is not possible to implement the same estimation procedure as previously. To render the estimation computationally tractable, we aggregate the circa 300 commuting zones into the 22 French metropolitan regions prevailing over the period.[34] As in the case of the affiliate level specifications, we estimate these regressions industry by industry.[35]

A new concern that arises from the fact that estimations are made at the group level is that variations of travel time are not due only to HSR line openings but also to change in the spatial organization of the group, and it is harder to argue that they are exogenous to our variables of interest. We therefore decompose the gross average travel time to affiliates $T_{jt}$ into two parts, in order to factor out the "pure" travel time effect (holding the structure of the group fixed) from the variation in travel time induced by changes in the spatial organization of the group (which however might also be driven by aspects related to travel time - see section 2.6, although these are unlikely to be the main determinants[36]):

$$\begin{aligned} T_{jt} &= \frac{\sum_{i\in\mathcal{F}_{jt}} T_{(ij)t}}{\text{Card } \mathcal{F}_{jt}} - \underbrace{\frac{\sum_{i\in\mathcal{F}_{jt_0}} T_{(ij)t_0}}{\text{Card } \mathcal{F}_{jt_0}}}_{\text{Normalization}} \\ &= \underbrace{\left(\frac{\sum_{i\in\mathcal{F}_{jt}} T_{(ij)t}}{\text{Card } \mathcal{F}_{jt}} - \frac{\sum_{i\in\mathcal{F}_{jt}} T_{(ij)t_0}}{\text{Card } \mathcal{F}_{jt}}\right)}_{\text{Change in rail travel time}} + \underbrace{\left(\frac{\sum_{i\in\mathcal{F}_{jt}} T_{(ij)t_0}}{\text{Card } \mathcal{F}_{jt}} - \frac{\sum_{i\in\mathcal{F}_{jt_0}} T_{(ij)t_0}}{\text{Card } \mathcal{F}_{jt_0}}\right)}_{\text{Change in group spatial dispersion}} \end{aligned} \quad (2.4)$$

where $\mathcal{F}_{jt}$ denotes the set of affiliates in group $j$ at date $t$ and $T_{(ij)t}$ is travel time between affiliate $i$ and the headquarter of group $j$ at date $t$.

In this setting, the effect of the group spatial dispersion will have to be interpreted with caution. The main concern is that spatial dispersion is probably positively correlated to the growth of the group. To mitigate this concern, we include in our control variables the number of affiliates in the group and, in any case, our interest is mainly on the "pure" travel time effect, which is less impacted by this issue.

[34] These regions have been recently officially aggregated into 12 larger metropolitan aggregates.

[35] Industry affiliation at the group level is given by the main share of employment in the first year of our panel.

[36] In principle we should rely on a more formal IV strategy to control from the endogenous changes in group spatial organization driven by HSR. It is however difficult to find such an IV. For example, using the first year spatial group organization as an IV remains somewhat endogenous for large groups, and is weakly informative for the many group structures which enter the sample without any affiliate, thus weakening the IV.

## 2.4 Results

### 2.4.1 Sample descriptive statistics

Table 2.1 provides a comprehensive description of the main empirical indicators in our sample of affiliates of multi-location groups. 4% of them (and 5% of the corresponding corporate groups) were affected by the new HSR line openings which occurred over the 1993 to 2011 period and experienced the associated reductions in rail travel times.[37] Unsurprisingly, these affiliates appear to be most often located further away from their respective headquarters than affiliates which did not experience any rail travel time reduction, since HSR is typically a long distance mean of transportation.[38] They are also more often headquartered in Paris, which is due to the fact that the HSR network is mostly organized like a spider web centered on the capital city (see figure 2.4). On average, average rail speed (distance divided by travel time) is lower than 100km/h in the years before the line openings, and around 110km/h in the years after. This is largely below the highest HSR commercial speed (320km/h), because most affiliates only benefit from HSR on a small portion of the track to their headquarters. Last, the industry affiliation of affiliates appears to be somewhat differentiated depending on the considered HSR line opening. This is driven by the specific industrial specialization of the areas which became connected to the HSR network: while the Northern line opened in 1994 benefited disproportionally (compared to population average) to affiliates of the manufacturing industries, and less to affiliates active in the retail, trade and finance industries, the converse is true for the Eastern line (opened in 2007).

### 2.4.2 Regression at the affiliate level

Table 2.2 contains our main results, estimated by the (1 digit) industry level. The most striking pattern is the consistently negative relation between travel time and the functional spe-

[37] Figures 2.9 and 2.12 in appendix 2.G complement table 2.1 and provide a full description of the distribution of travel time reductions at the dates of the main line openings, as well as their precise geographical location. Affiliates which benefited from the HSR line openings in 1994 and 2001 were mainly located in the North and in the South of France, because the new HSR lines opened at these dates mainly improved the north/south connections. The Eastern line opened in 2007 mainly benefited affiliates located along the new line, and to a much lesser extent to affiliates located in the South-western part of France. The associated distributions of travel time reductions appear to be quite differentiated: travel time reductions are clustered below 25 minutes in 1994, with very few cases of travel time reduction exceeding this value. In 2001, there are two modes in the distribution, at 5 and 55 minutes respectively. Last, the distribution obtained for 2007 is flatter, with many rail travel time reductions staggered between 0 and 90 minutes, combined with a larger mass point at 90 minutes.

[38] Typically, 40% of the affiliates that are unaffected by HSR are located in the same employment zone as their HQ (see table 2.12 in appendix 2.D.3 for complementary descriptive statistics).

Table 2.1: Summary statistics

*Affiliates of multi-location firms, 1993-2011*

| | **Affiliates experiencing reductions in travel time between 1993 and 2011** | | | | **Affiliates never affected** |
|---|---|---|---|---|---|
| | | **At main years of change:** | | | |
| | **1993-2011** | **1993/1994** | **2000/2001** | **2006/2007** | |
| *Geography:* | | | | | |
| Distance to HQ (km) | 411 | 478 | 488 | 334 | 205 |
| HQ in Paris | 41% | 49% | 36% | 39% | 36% |
| *Travel times (hours):* | | | | | |
| Travel time after treatment | 3.93 | 4.15 | 4.20 | 3.12 | 2.13 |
| Variation in travel time | - | -0.20 | -0.70 | -0.93 | - |
| New HSR user | - | 7% | 15% | 63% | - |
| *Workforce and wages at affiliates:* | | | | | |
| Employment | 36 | 38 | 31 | 30 | 32 |
| Share of production workers | 56% | 58% | 57% | 55% | 59% |
| Annual wage of op. workers (k€) | 15.7 | 15.2 | 14.8 | 17.0 | 16.1 |
| Share of managers | 8% | 9% | 8% | 8% | 8% |
| *Industry affiliation:* | | | | | |
| Manufacturing industries | 15% | 21% | 15% | 13% | 16% |
| Personnel services | 8% | 11% | 7% | 5% | 10% |
| Retail and Trade | 39% | 32% | 39% | 41% | 40% |
| Business Services | 14% | 18% | 18% | 16% | 16% |
| Transport | 6% | 9% | 7% | 5% | 5% |
| Finance | 18% | 9% | 15% | 19% | 13% |
| *Counts of business units:* | | | | | |
| Nb observations (affiliates × year) | 253,287 | 7,061 | 11,882 | 9,633 | 2,573,936 |
| Nb affiliates | 35,429 | // | // | // | 856,840 |
| Nb HQs (groups) | 10,762 | 2,865 | 4,712 | 3,078 | 216,483 |

Sources: Matched DADS files and LIFI survey; business units (HQs or affiliates - see section 2.2.1 for definition) which are part of multi-location groups between 1993 and 2011. Employment is measured in days of work but is reported in this table as headcount equivalents (days divided by 360).
Notes: The main "years of change" correspond to the opening dates of the Northern line (1993/1994), of the connection to Marseille (2000/2001) or of the Eastern line (2006/2007).

cialization of affiliates into production activities. Estimated coefficients range between around 0.5 percentage point of decrease in the employment share of production activities per hour of transport, which is the value obtained in the finance, retail and trade industries, to around 1 percentage point per hour in the manufacturing industries, and 2 percentage point per hour in industries related to services (personnel services, business services and transport). The average travel time between affiliates and headquarters is around 2 hours (table 2.1) such that these estimates imply shifts of the workforce structure ranging from 1 to 4 percentage points on average. In most industries, they are also associated with positive correlations between travel times and the share of managers at affiliates: the higher ratio of managers per worker when travel times are higher indicates that geographical dispersion generates higher local managerial needs.

The relation between (decreases in) travel time and functional specialization is highest in the service industries, which is consistent with Petersen and Rajan (2002). These authors suggest that the mechanisms relating organizational structure and the use of information presented in section 2.1 are most relevant in industries where information to be transmitted is particularly "soft". In their view, this is the case when activity relies heavily on relationship building, such as consulting, research and new product development, and more generally service industries.[39] In contrast, the relation between travel time and functional specialization estimated in the trade, retail and manufacturing industries is somewhat less pronounced. In the latter case of the manufacturing industries, this result might also be driven by the fact that adjustments in production employment might require complementary adjustment in capital, and therefore a significant costly investment effort, as in Giroud (2013) and Giroud and Mueller (2015).

In column (5) of table 2.2, we investigate the relation between travel times and the wage of production workers. The obtained relation is most often positive, but only significant in the manufacturing and business services industries. This seems unsurprising, since we expect the knowledge based mechanism in section 2.1.3 to be more relevant in those most skill intensive industries.[40] Magnitudes are relatively large: the average geographical dispersion within French corporate groups, requiring 2h of travel time between affiliates and headquarters, would translate into a 2% increase in operational costs driven by the higher wages paid out.

[39] A surprising result in this respect in table 2.2 is the weak coefficient obtained in the case of the finance industry. This is most likely because our empirical indicator of production activities is inadequate (see section 2.2.2) in this industry: it only captures 10% of the workforce, which seems excessively low. In contrast, this industry presents disproportionate shares of managers (17%, as opposed to ca 5% in other industries) and middle skilled administrative workers (46%, as opposed to around 20% in other industries), which suggests that part of production workers are non technical and therefore (mis)classified into the same occupational categories as administrative workers, which generates a measurement problem in our setting.

[40] See section 2.2.2 for basic descriptive statistics. Again, the lack of significance in the case of the finance industry (which is also highly skill intensive) might be driven by the inaccuracy of our indicator of production activities.

Table 2.2: Travel Time to HQ and the Structure of the Workforce at Affiliates

*1993-2011, affiliates of multi-location corporate groups only*

| | **Affiliate employment (ln)** | | **Structure of the workforce (shares)** | | **Wage (ln)** |
|---|---|---|---|---|---|
| | **Total** | **Prod. workers** | **Prod. workers** | **Managers** | **Prod. workers** |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** |
| | | | **(A) Manufacturing Industries** | | |
| Travel time (hours) | -0.013 | -0.019* | -0.009*** | 0.002* | 0.008** |
| | (0.009) | (0.010) | (0.002) | (0.001) | (0.004) |
| Mean of unlogged dep. var. | 60.670 | 48.915 | 0.753 | 0.046 | 18,334 |
| Observations | 426,595 | 408,861 | 426,595 | 426,595 | 408,861 |
| | | | **(B) Personnel Services** | | |
| Travel time (hours) | 0.005 | -0.055*** | -0.020*** | 0.018*** | 0.009 |
| | (0.016) | (0.019) | (0.005) | (0.002) | (0.008) |
| Mean of unlogged dep. var. | 23.089 | 15.835 | 0.733 | 0.047 | 13,204 |
| Observations | 241,846 | 227,936 | 241,846 | 241,846 | 227,936 |
| | | | **(C) Retail and Trade** | | |
| Travel time (hours) | -0.022*** | -0.030*** | -0.008*** | -0.002*** | -0.004 |
| | (0.005) | (0.006) | (0.002) | (0.001) | (0.002) |
| Mean of unlogged dep. var. | 16.848 | 11.094 | 0.660 | 0.060 | 13,925 |
| Observations | 1,045,869 | 965,013 | 1,045,869 | 1,045,869 | 965,013 |
| | | | **(D) Business Services** | | |
| Travel time (hours) | -0.009 | -0.070*** | -0.018*** | 0.000 | 0.013* |
| | (0.011) | (0.015) | (0.003) | (0.002) | (0.008) |
| Mean of unlogged dep. var. | 45.814 | 29.755 | 0.515 | 0.114 | 19,538 |
| Observations | 401,844 | 329,680 | 401,844 | 401,844 | 329,680 |
| | | | **(E) Transport** | | |
| Travel time (hours) | 0.018 | 0.006 | -0.016*** | 0.012*** | 0.001 |
| | (0.016) | (0.022) | (0.005) | (0.003) | (0.009) |
| Mean of unlogged dep. var. | 38.610 | 26.857 | 0.584 | 0.052 | 17,811 |
| Observations | 138,865 | 115,205 | 138,865 | 138,865 | 115,205 |
| | | | **(F) Finance** | | |
| Travel time (hours) | 0.031** | 0.000 | -0.005* | 0.006* | 0.010 |
| | (0.013) | (0.037) | (0.003) | (0.004) | (0.023) |
| Mean of unlogged dep. var. | 27.485 | 3.618 | 0.102 | 0.168 | 16,437 |
| Observations | 348,836 | 104,192 | 348,836 | 348,836 | 104,192 |

Sources: Matched DADS files and LIFI survey; affiliates (see definition in section 2.2.1) which are part of multi-location groups between 1993 and 2011.

Note: All regressions include affiliate $\times$ headquarter level fixed effects, as well as local (commuting zone) $\times$ time fixed effects to control for the local market conditions. Regressions also include group level exports in total sales to capture the cycle on international markets (but all results are robust to the exclusion of these controls).

In most industries, there is no significant effect on affiliate total employment and the functional specialization therefore translates into significant negative correlations between travel times to headquarters and affiliate production employment (column 2 in table 2.2). Two exceptions are retail and trade and finance industry. For retail and trade, the significant negative relation between travel time to headquarters and total employment is consistent with mechanisms described by of Giroud and Mueller (2015). For the finance industry, the sign is reverse, so there might be a productivity effect of travel time but as there is no information on productivity at the plant level, this can not be investigate further. So empirical findings of Giroud and Mueller (2015) for the US manufacturing industry employment, do not seem to fully apply to France and to a wider set of industries.

But we further follow Giroud and Mueller (2015) and investigate whether the employment and management of affiliates might be affected by the other business units in the group (table 2.3). This would occur, for example, if HQ managerial time is a scarce resource (Giroud, 2013), or if the group is financially constrained such that all desirable adjustments do not take place (Giroud and Mueller, 2015). To that end, we insert into the regression, variables describing the variations of average travel time to other affiliates in the group.

Columns (1) and (2) show that these resource constraint mechanisms are likely to drive a downward bias in our baseline regression for total affiliate employment. Indeed, we obtain that affiliate total employment growth is negatively affected by decreases (or positively affected by increases) in travel time at other affiliates in all industries. In these enriched specifications, the coefficient associated with own travel time also becomes significant (and negative) in the manufacturing industries, retail, trade and business services, which suggests that the relation between affiliate size and travel time (explained in section 2.1.1) suffered from attenuation bias in table 2.2 and that empirical findings of Giroud and Mueller (2015) can indeed be extended to France in these industries.

Columns (3) and (4) show that functional specialization tends to be slightly fostered (but not impaired) by variations in travel time at other affiliates. This finding might be driven by the fact that HQ manager time that is saved at other affiliates (due to shorter travels) is partially reallocated to remote affiliates, thus decreasing the need for local managers and fostering their functional specialization. Overall, table 2.3 suggest that HQ managerial time might be a particularly scarce resource (or costly input) in large and spatially dispersed groups.

Table 2.3: Impact of Travel Time to Other Affiliates in Group

*1993-2011, affiliates of multi-location corporate groups only*

| Dependent variable: | **Employment (ln)** | | **Share of Production emp.** | |
|---|---|---|---|---|
| | **Own travel time (1)** | **Variations at other affiliates (2)** | **Own travel time (3)** | **Variations at other affiliates (4)** |
| Manufacturing industries | -0.018* | 0.025*** | -0.009*** | 0.000 |
| | (0.009) | (0.002) | (0.002) | (0.000) |
| Personnel services | 0.002 | 0.027*** | -0.020*** | -0.002** |
| | (0.016) | (0.004) | (0.005) | (0.001) |
| Retail and trade | -0.033*** | 0.057*** | -0.007*** | -0.002*** |
| | (0.005) | (0.001) | (0.002) | (0.000) |
| Business services | -0.024** | 0.057*** | -0.018*** | 0.002*** |
| | (0.011) | (0.003) | (0.003) | (0.001) |
| Transport | 0.014 | 0.030*** | -0.016*** | -0.002** |
| | (0.016) | (0.004) | (0.005) | (0.001) |
| Finance | 0.019 | 0.104*** | -0.005* | -0.001* |
| | (0.013) | (0.004) | (0.003) | (0.001) |

Sources: Matched DADS files and LIFI survey; affiliates (see definition in section 2.2.1) which are part of multi-location groups between 1993 and 2011.
Note: All regressions include affiliate $\times$ headquarter level fixed effects, as well as local (commuting zone) $\times$ time fixed effects to control for the local market conditions. Regressions also include group level exports in total sales to capture the cycle on international markets. Same samples and numbers of observations as in table 2.2.

### 2.4.3 Regressions at the group Level

As a complementary piece of evidence, in table 2.4, we run regressions at the entire group level which unable us to gauge the impact of travel time on global operating profits and other operational decisions - mainly, investment decisions.

Though the identification strategy is not as strong as for the affiliate level,[41] the obtained results provide a remarkably consistent picture. First, the remoteness of affiliates is associated with fewer administrative workers, or fewer managers at HQs relative to affiliates (columns (3) and (5) of panel (A) of table 2.4), which would be consistent with increased delegation of authority to local managers of affiliates. The obtained pattern of correlations is highly significant and coherent across all industries. The obtained estimates are higher than the decreases in the share of managers documented in table 2.2, which would imply that the sum of all adjustments of managerial resources at remote affiliates, downwards (when travel time decreases) or upwards (when travel time increases), are more than compensated by the symmetric adjustments at headquarters.

In terms of growth and profit, the most striking result is the highly significant negative correlation between travel time and profit margin which is obtained in all industries (column (5) of panel (B) of table 2.4). In column (3) of panel (B) of table 2.4, we also obtain that investment is always negatively correlated with travel time, a result which is consistent with Giroud Giroud (2013), although the relation is only significant in the retail, trade, transport and finance industries. The correlation with employment is highly differentiated across industries: while travel time is found to be negatively correlated with total employment in the manufacturing, personnel services and retail and trade industries, it seems that a productivity effect (of more efficient and parsimonious managerial organizations made possible by reduced travel times) dominates and reverses the relation in the business services, transport and finance industries.

Last, although there might be some remaining endogeneity issues on the estimates of the impact of spatial dispersion on group performance, the indicator of group level spatial dispersion (defined in equation 2.4) is found to be consistently negatively correlated with group size (as measured by total value added or employment), investment, and operational profit margin.

[41] See section 2.3.2 for a discussion.

Table 2.4: Spatial Dispersion and Performance at the Group Level

*1993-2011, corporate groups which are geographically dispersed only*

(A) Workforce

| | **ln Group employment** | | **Sh. admin at HQ in total admin** | | **Sh. managers at HQ in total admin** | | |
|---|---|---|---|---|---|---|---|
| | **Travel time (1)** | **Spatial disp. (2)** | **Travel time (3)** | **Spatial disp. (4)** | **Travel time (5)** | **Spatial disp. (6)** | **Obs.** |
| **Manufacturing industries** | -0.026* | -0.032*** | -0.012*** | 0.004*** | -0.026*** | 0.000 | 230,041 |
| | (0.014) | (0.002) | (0.004) | (0.000) | (0.005) | (0.001) | |
| **Personnel services** | -0.074*** | -0.042*** | -0.041*** | -0.011*** | -0.027*** | -0.008*** | 134,951 |
| | (0.025) | (0.002) | (0.008) | (0.001) | (0.009) | (0.001) | |
| **Retail and trade** | -0.049*** | -0.028*** | -0.035*** | -0.004*** | -0.022*** | -0.001*** | 417,799 |
| | (0.012) | (0.001) | (0.004) | (0.000) | (0.005) | (0.001) | |
| **Business services services** | 0.082*** | -0.059*** | -0.040*** | -0.003*** | -0.025*** | 0.001* | 257,055 |
| | (0.015) | (0.002) | (0.003) | (0.000) | (0.005) | (0.001) | |
| **Transport** | 0.040* | -0.025*** | -0.008 | 0.008*** | -0.019** | 0.000 | 53,868 |
| | (0.024) | (0.003) | (0.007) | (0.001) | (0.008) | (0.001) | |
| **Finance** | 0.080** | -0.012*** | -0.044*** | -0.014*** | -0.042*** | -0.008*** | 74,668 |
| | (0.031) | (0.004) | (0.007) | (0.001) | (0.009) | (0.001) | |

(B) Growth and Profit

| | **ln Value Added** | | **ln Investment** | | **Profit Margin** | | |
|---|---|---|---|---|---|---|---|
| | **Travel time (1)** | **Spatial disp. (2)** | **Travel time (3)** | **Spatial disp. (4)** | **Travel time (5)** | **Spatial disp. (6)** | **Obs.** |
| **Manufacturing industries** | -0.067*** | -0.017*** | -0.037 | -0.020*** | -0.008** | -0.003*** | 225,942 |
| | (0.014) | (0.002) | (0.035) | (0.004) | (0.003) | (0.000) | |
| **Personnel services** | -0.107*** | -0.044*** | -0.064 | -0.003 | -0.010* | -0.004*** | 131,829 |
| | (0.024) | (0.002) | (0.067) | (0.006) | (0.006) | (0.001) | |
| **Retail and trade** | -0.049*** | -0.017*** | -0.146*** | -0.013*** | -0.011*** | -0.004*** | 406,310 |
| | (0.013) | (0.001) | (0.034) | (0.004) | (0.003) | (0.000) | |
| **Business services services** | 0.029** | -0.041*** | -0.015 | -0.066*** | -0.007** | -0.003*** | 249,263 |
| | (0.014) | (0.002) | (0.030) | (0.004) | (0.003) | (0.000) | |
| **Transport** | -0.017 | -0.008** | -0.232*** | -0.034*** | -0.017*** | -0.002*** | 52,936 |
| | (0.024) | (0.003) | (0.059) | (0.007) | (0.005) | (0.001) | |
| **Finance** | 0.072* | -0.023*** | -0.254*** | -0.038*** | -0.014* | -0.003*** | 69,823 |
| | (0.037) | (0.005) | (0.073) | (0.009) | (0.008) | (0.001) | |

Sources: Matched DADS files and LIFI survey; groups owning affiliates in different locations (commuting zones) for at least one year between 1993 and 2011.
Note: All regressions include group level fixed effects, as well as local variable describing the employment share of the group in each French region, interacted with years (to capture local market conditions). Regressions also include the logarithm of the total number of implantations (HQ and affiliates) as well as group level exports in total sales to capture the business cycle on international markets.

## 2.5 Robustness checks

### 2.5.1 Common trend assumption and non-linear impacts

The discussion in section 2.3.1 shows that our setting is similar to a difference-in-differences setting, where we contrast affiliates experiencing changes in travel times to their headquarters with affiliates located in the same area which did not experience the same changes, because of a different location of their headquarters. To test the common trend identifying assumption underlying such a setting, and to investigate potential anticipation effects (or conversely, lagged adjustment processes), we run a specification where we include lags and leads of our indicator of travel time. Results are reported in the first three columns of table 2.5, for our indicator of functional specialization (the share of employment allocated to production activities).

If anything, we detect anticipation effects in the business and personnel services industries; unreported results show that these anticipation effects do not exceed one year. Lagged adjustments only occur in the transport industry. Overall, although the simultaneous inclusion of three indicators of travel times is probably too demanding in our setting, this experiment shows that the response to changes in travel times occurs mostly in the year where affiliates experience them in the manufacturing industries, personnel services, retail and trade and business services.

Columns (4) to (6) in table 2.5 propose a different experiment. In this second specification, we investigate the potential non-linearities underlying our main results in table 2.2 and split our travel time variable into three different classes: short travels, lasting less than 3hours, medium length travels, lasting between 3 and 5hours and which would still be feasible (round trip) in one day, and longer travels, lasting more than 5 hours. We obtain that in almost all industries except in the finance industry, the relation between travel time and functional specialization is low and insignificant for the shortest travels. In contrast, the relation is always highly significant for medium range travels, which drive our main results in table 2.2. In most industries (manufacturing industries, personnel and business services, transport), the longest trips also contribute significantly to our results. These findings are consistent with the descriptive statistics reported in table 2.A of appendix 2.10, which show that the market share of HSR is highest for the market segment of the longest trips.

### 2.5.2 Alternative identification strategies

Table 2.6 presents a series of important experiments, where we vary the identification strategy in order to test the robustness of our findings. As previously, for compactness, results are only

Table 2.5: Anticipation *vs.* Adjustment Effects, Non-Linearities

*1993-2011, affiliates of multi-location corporate groups only*

| (Dependent variable: Share of prod. emp.) | **Anticipations and adjustments** | | | **Non-linear impact of travel time** | | |
|---|---|---|---|---|---|---|
| | **Travel time at:** | | | **Travel time at t:** | | |
| | $t-1$ | $t$ | $t+1$ | **shorter than 3h** | **3h to 5h** | **longer than 5h** |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Manufacturing industries | 0.000 | -0.008* | -0.001 | -0.004 | -0.009** | -0.015*** |
| | (0.003) | (0.004) | (0.004) | (0.003) | (0.004) | (0.004) |
| Personnel services | -0.012* | -0.011 | -0.002 | -0.008 | -0.030*** | -0.024** |
| | (0.007) | (0.008) | (0.007) | (0.007) | (0.007) | (0.009) |
| Retail and trade | -0.004* | -0.006** | 0.002 | -0.001 | -0.020*** | -0.004 |
| | (0.002) | (0.003) | (0.002) | (0.002) | (0.003) | (0.003) |
| Business services | -0.012*** | -0.010** | 0.001 | -0.008* | -0.010** | -0.038*** |
| | (0.004) | (0.005) | (0.004) | (0.005) | (0.005) | (0.005) |
| Transport | 0.011 | -0.007 | -0.023*** | -0.009 | -0.023*** | -0.021** |
| | (0.007) | (0.008) | (0.007) | (0.006) | (0.007) | (0.009) |
| Finance | -0.006 | 0.000 | -0.001 | -0.026*** | 0.017*** | -0.006 |
| | (0.004) | (0.005) | (0.004) | (0.003) | (0.003) | (0.004) |

Sources: Sources: Matched DADS files and LIFI survey; affiliates (see definition in section 2.2.1) which are part of multi-location groups between 1993 and 2011.
Note: All regressions include affiliate $\times$ headquarter level fixed effects, as well as local (commuting zone) $\times$ time fixed effects to control for the local market conditions. Regressions also include group level exports in total sales to capture the cycle on international markets Same samples and numbers of observations as in table 2.2.

presented for our indicator of functional specialization (the share of employment allocated to production activities). Column (1) simply replicates the results of table 2.2 as a benchmark. In columns (3) and (5), we only use each third or fifth year in our panel, in order to identify the impact of travel time on longer time differences. The cost of this strategy is obviously the drastic decrease in sample size. Results are fully preserved in this experiment. We tend to obtain higher point estimates when increasing the length of the time difference, but this finding might be driven by the selection of survivors that is induced by this experiment.

In column (5), we estimate a specification where we remove the largest affiliates in each commuting zone. This experiment is meant to test whether our results could be driven by this sub-population of affiliates, which are most likely to be at the source of the endogeneity concerns related to potential lobbying activity. Our results are however fully preserved. In column (6), we propose another experiment which is directly inspired from Giroud (2013).[42] In this specification, we only use affiliates which only benefit from HSR for less than 50% of the track to their headquarters. These observations are less likely to have lobbyied in favor of the HSR line than those benefiting from it on the entire track to their headquarters. Again, results are fully preserved in this experiment: if anything, we obtain higher point estimates than in the baseline specification.

Last, column (6) of table 2.6 contains the evidence obtained from unrealized lines (see section 2.3.1). It amounts to restrict the sample to affiliates which would have benefited from the initial 1991 plan voted by the government if it had been implemented. Again, results are however preserved, and even somewhat amplified in the cases of the manufacturing, personnel and business services industries.

[42]The setting in Giroud (2013) is very similar to ours: this author estimates the effects of headquarters' proximity to plants on plant-level investment and productivity using the opening of US airlines. To mitigate concerns related to lobbying, he proposes specifications where he only considers indirect flights where either the last leg of the flight (involving the plants home airport) or the first leg of the flight (involving headquarters home airport) remains unchanged.

Table 2.6: Alternative Identification Strategies

*1993-2011, affiliates of multi-location corporate groups only*

| Dependent variable: share of production employment | | **Baseline** | **Longer time differences:** | | **Removing largest** | **Partial HSR track only** | **1991 plan only** |
|---|---|---|---|---|---|---|---|
| | | | **3 years** | **5 years** | | | |
| | | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Manufacturing industries | Coef. | -0.009*** | -0.009** | -0.017** | -0.008*** | -0.014*** | -0.019*** |
| | | (0.002) | (0.005) | (0.008) | (0.002) | (0.003) | (0.004) |
| | Obs. | 426,595 | 156,189 | 86,121 | 423,677 | 369,587 | 209,537 |
| Personnel services | Coef. | -0.020*** | -0.009 | -0.049*** | -0.020*** | -0.022*** | -0.026*** |
| | | (0.005) | (0.011) | (0.018) | (0.005) | (0.007) | (0.007) |
| | Obs. | 241,846 | 89,653 | 53,552 | 238,931 | 209,326 | 116,566 |
| Retail and trade | Coef. | -0.008*** | -0.006* | -0.002 | -0.008*** | -0.008*** | -0.007** |
| | | (0.002) | (0.003) | (0.005) | (0.002) | (0.002) | (0.003) |
| | Obs. | 1,045,869 | 382,129 | 230,819 | 1,043,053 | 917,541 | 464,929 |
| Business services | Coef. | -0.018*** | -0.016** | -0.035*** | -0.017*** | -0.030*** | -0.025*** |
| | | (0.003) | (0.006) | (0.012) | (0.003) | (0.004) | (0.005) |
| | Obs. | 401,844 | 148,698 | 90,025 | 399,065 | 334,041 | 202,592 |
| Transport | Coef. | -0.016*** | -0.032*** | -0.024* | -0.016*** | -0.024*** | -0.015* |
| | | (0.005) | (0.009) | (0.015) | (0.005) | (0.007) | (0.008) |
| | Obs. | 138,865 | 50,795 | 30,714 | 136,052 | 117,185 | 65,123 |
| Finance | Coef. | -0.005* | -0.005 | -0.019*** | -0.004* | 0.002 | 0.002 |
| | | (0.003) | (0.005) | (0.007) | (0.003) | (0.003) | (0.004) |
| | Obs. | 348,836 | 128,286 | 76,777 | 345,895 | 284,478 | 174,259 |

Sources: Matched DADS files and LIFI survey; affiliates (see definition in section 2.2.1) which are part of multi-location groups between 1993 and 2011.
Note: All regressions include affiliate $\times$ headquarter level fixed effects, as well as local (commuting zone) $\times$ time fixed effects to control for the local market conditions. Regressions also include group level exports in total sales to capture the cycle on international markets.

## 2.6 Descriptive extension for the extensive margin

### 2.6.1 Empirical tools

Affiliate creation and destruction can not be studied in the previous regression framework but they are controlled for since in practice these events are well captured by the affiliate level fixed effects (which "purge" regressions from most of the selection bias which could arise). A thorough econometric treatment of these events would require the specification of a discrete choice model of implantation across commuting zones, which would not fit our main identification strategy (in section 2.3.1). We leave this aspect for future research but propose as in Giroud (2013) a series of regressions describing the relation between affiliate creation or destruction and travel time.

For affiliate destruction, we propose a direct extension of the previous regression framework:

$$EXIT_{ijlt} = \alpha_j + \alpha_{lt} + \beta.T_{ijlt} + \gamma.X_{jt} + \varepsilon_{ijlt} \tag{2.5}$$

where $EXIT_{ijlt}$ is a dummy variable indicating that the considered affiliate is exiting from the group.[43] In our panel, inclusion of affiliate $\times$ group fixed effects (as in equation 2.2) would capture too much heterogeneity because affiliates are on average present for only 3.2 years in our panel. We therefore replace the affiliate $\times$ group fixed effects in equation 2.2 with group level fixed effects, which preserve the identification of the $\beta$ coefficient from variations in travel time. Equation 2.5 is then estimated as a linear probability model, using the same estimation procedure as in section 2.3.1.

Our treatment of affiliate creations[44] is different and less powerful, since we can't rely on *variations* in travel time for such events. As in Giroud (2013), we simply choose to describe characteristics of the new affiliates $Z_{ijlt}^{CREA}$: we document whether new affiliates are set up further or closer away (in terms of geographical distance or travel time $T_{ijt}$), or whether an HSR line is available for travels between these affiliates and their headquarters, as a function of the size of the created affiliate, the total number of affiliates within group, *etc*. (variables in $X_{ijt}$).

[43] Affiliate "destruction" corresponds to actual closures or to resale of affiliates, while the group itself still operates in the same industry, with other affiliates (to abstract from more global market exit decisions).

[44] Affiliate "creation" correspond to actual creations or to acquisitions in our setting. We only consider affiliate creation in pre-existing groups, which were furthermore already operating in the same industry (to abstract from global market entry decisions).

$$Z_{ijlt}^{CREA} = \alpha_{lt} + \beta.T_{ijt} + \gamma.X_{ijt} + \varepsilon_{ijlt} \tag{2.6}$$

Commuting zone $\times$ time fixed effects are still identified and allow to control very precisely for local shocks in these regressions.

### 2.6.2 Affiliates exits and entries

If travel time (and proximity) affects the management of remote affiliates, then it might also affect the decision related to affiliate closures and openings. We first investigate closures in table 2.7.We obtain that everything else equal, more distant affiliates (in terms of travel times) have a higher probability to be terminated, either because they are more difficult to manage and/or because they are less profitable - or simply because they are also "politically" distant (Bassanini et al., 2015). These correlations tend to be higher in service industries (business services, and especially finance industries). We also obtain that affiliates who benefited from gains in travel time thanks to the HSR network expansion were less likely to get terminated, while the probability of closure was also highly significantly reduced by gains at other affiliates, which tends to confirm the resource constraints story.

Table 2.7: Travel Time and the Reshuffling of Affiliates: Exits

*1993-2011, affiliates of multi-location corporate groups only*

| Dependent variable: probability of exit | **Manufacturing Industries** **(1)** | **Personnel Services** **(2)** | **Retail and Trade** **(3)** | **Business Services** **(4)** | **Transport** **(5)** | **Finance** **(6)** |
|---|---|---|---|---|---|---|
| Travel time | 0.017*** | 0.014*** | 0.014*** | 0.022*** | 0.017*** | 0.026*** |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.001) | (0.000) |
| Gains since entry | -0.014*** | 0.012** | -0.024*** | -0.015*** | -0.023*** | -0.066*** |
| | (0.004) | (0.005) | (0.002) | (0.004) | (0.006) | (0.003) |
| Gains at other affiliates | -0.011*** | -0.018*** | -0.010*** | -0.011*** | -0.016*** | -0.016*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.002) |
| Share of exits | 0.428 | 0.354 | 0.415 | 0.465 | 0.423 | 0.485 |
| Observations | 426,487 | 241,677 | 1,045,416 | 401,694 | 138,778 | 348,801 |

Sources: Matched DADS files and LIFI survey; affiliates (see definition in section 2.2.1) which are part of multi-location groups between 1993 and 2011.
Note: All regressions include affiliate $\times$ headquarter level fixed effects, as well as local (commuting zone) $\times$ time fixed effects to control for the local market conditions. Regressions also include group level exports in total sales to capture the cycle on international markets.

The characteristics of affiliate entries are described in table 2.8. More precisely, we investigate whether geographic distance or travel time to headquarters are related to different charac-

Table 2.8: Travel Time and the Reshuffling of Affiliates: Characteristics of Entries

*1993-2011, affiliates of multi-location corporate groups only*

| Dependent variable: | **Distance (ln) (1)** | **Travel time (2)** |
|---|---|---|
| Employment of affiliate (ln) | -0.054*** | -0.032*** |
| | (0.001) | (0.002) |
| Gains at other affiliates | 0.088*** | 0.009** |
| | (0.003) | (0.004) |
| Other affiliate entry(ies) in same group (dummy) | -0.219*** | -0.200*** |
| | (0.008) | (0.011) |
| Other affiliate exit(s) in same group (dummy) | -0.099*** | -0.044*** |
| | (0.009) | (0.011) |
| Other affiliates are HSR users | 2.061*** | 1.724*** |
| | (0.008) | (0.010) |
| Mean (un-logged) dependent variable | 282 | 2.951 |
| Observations | 404,427 | 404,427 |

Sources: Matched DADS files and LIFI survey; affiliates (see definition in section 2.2.1) which are part of multi-location groups between 1993 and 2011.
Note: All regressions include industry (2 digits) $\times$ local (commuting zone) $\times$ time fixed effects to control for the local market conditions, as well as (4digit) industry dummies. Regressions also include the (ln) number of affiliates in the group as well as the group level exports in total sales to capture the cycle on international markets.

teristics of the group which might also "tap" into the scarce HQ managerial resources that are to be shared across all affiliates. We obtain that larger affiliates, which are likely to be more difficult to manage remotely (or for which the "size of stake" might be larger) tend to be created closer to their headquarters, whatever the indicator of distance. Similarly, when other affiliates experienced gains in travel time, thus freeing some HQ managerial resources, then affiliates tend to be created at a greater distance (to enhance the gains to split, e.g. by settling closer to their final market, at the cost of a larger managerial cost). Last, affiliate churning (creation but also destruction), which might be demanding in terms of headquarters' managerial resources, are both negatively correlated with distant affiliate creations. Un-reported regressions show that all of these results also hold industry by industry.

# Conclusion

In this paper, we documented the impact of travel time between affiliates and headquarters of geographically dispersed corporate groups on the management of such business organizations. Guided by theory, we tested predictions on the population of French corporate groups, using the expansion of the High Speed Rail network as an arguably exogenous shock on internal

travel times. First, we obtained that a functional specialization induced by decreases in travel times occurred in all industries and that it was most pronounced in the service industries, where information to be transmitted is arguably softer (Petersen and Rajan, 2002). It amounts to the shift of roughly one job from administrative to production activities, against 20% of a job in other industries (retail, trade or manufacturing). At the group level, our regressions suggest that it translates into an increase in the share of managers at headquarters. Second, we found evidence that travel time between affiliates and headquarter can be considered as a monitoring cost that leads to asymmetries of information and lower employment growth in remote affiliates in most industries as found by Giroud and Mueller (2015) for the US manufacturing industry. We also obtain evidence that managerial time is a scarce resource such that the management and the employment growth of an affiliate is impacted by travel time from other affiliates to the headquarters. This suggests that the management of spatially dispersed group is costly and less efficient. Indeed, our results at the group level suggest that the impact on the operational profit margin (in particular, via reduced labor costs) is significant in all industries.

Though suggestive of the interplay between communication and management in spatially dispersed business organizations, our results leave several questions open. First, we leave for future research the more ambitious question of the impact of HSR on group level overall geographic configuration decisions: location / relocation / splitting decisions in particular for affiliates that are specialized in support activities within the group. This more global analysis of firm organization would require an entirely different identification strategy. Second, we focused in this paper on within group, HQ to affiliate communication. Natural extensions of our work would be to extend the analysis to within group between affiliates communication and, more importantly, to external communication: between firms and their suppliers or customers as in Bernard et al. (2015), or between firms and investors (banking relationships as in Bernstein et al. (2015), access to public programs, etc.). These aspects could have non-negligible productivity or profitability impacts as well.

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# Appendices

# 2.A The business travels of managers: HSR or Air?

## 2.A.1 Business travels by managers account for a significant share of HSR travels

Table 2.9 is constructed from the most recent survey data about transports and provides a breakdown of the clients of each mode of transportation in 2008[45]. It shows that most HSR travels have a private motivation, with only 35% of them having a business motivation - which is a lower share than in the case of air or standard rail travels. However and strikingly in the case of HSR, this contribution of business travels to total HSR traffic is largely driven by managers: they account for 20% of *total* HSR domestic travels, and to more than half of *business* HSR travels. Altogether, these figures suggest that managers, despite their low weight in the workforce (typically 9 to 10%) are a non-negligible segment of HSR customers, in particular among "business" customers.

Table 2.9: Break-down of Long Distance Domestic Travels by Main Purpose, in 2008

*For each mode of transportation, by type of user (%)*

| Main purpose: | Private Trips | | | Business Trips | |
|---|---|---|---|---|---|
| Type of users: | All | *(High income)* | *Managers* | All | *Managers* |
| Car | 86 | *(33)* | *10* | 14 | *5* |
| HSR | 65 | *(29)* | *11* | 35 | *20* |
| Other Rail | 46 | *(13)* | *5* | 54 | *19* |
| Bus | 89 | *(20)* | *1* | 12 | *1* |
| Air | 54 | *(28)* | *14* | 45 | *32* |

Sources: SOES, Transport and travel survey, 2008.
Note: This survey was collected at the household level. Income is measured at the household (not respondent) level. "High income" corresponds to the top quartile of the income distribution (total household income, normalized by units of consumption). The category "Managers" describes the occupation of the respondent.
Managers account for 20% of all HSR trips. This represents 20/35 = 57% of HSR business trips.

The disproportionate contribution of managers to HSR travels is first driven by the fact that they travel more in absolute terms: they contribute more to business travels, whatever the mean of transportation, than their relative weight in the workforce. Second, their contribution is even

[45]For homogeneity concerns, we restrict the analysis to domestic trips, since in this paper we focus on domestic HSR routes.

more disproportionate for means of transportation dedicated to long distance travels: HSR and planes.

### 2.A.2 HSR market share for long distance business travels: 1994 *vs.* 2008

Table 2.10 investigates what is the precise "market" of HSR, and what are its main competitors[46]. First, the market share of HSR is highest, among domestic business travels, for the longest trips: it reaches 42% on the segment of very long distance travels (longer than 800km), on which airlines capture the second largest market share (33%). For travels of intermediate length, the market share of HSR is still of 24%, but the contribution of other rail is larger (31%), while it is negligible in the category of the longest trips. Symmetrically, air becomes a residual category in the range of travels of intermediate length. Altogether, these results suggest that over the recent period, HSR is one of the most popular mean of transportation for the longest domestic business travels.

Table 2.10: "Market Share" of Each Mode of Transportation by Market Segment

*Domestic Business Travels Only*

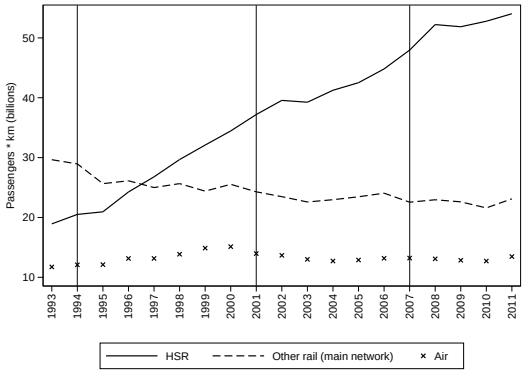
| | Market shares in 1994 | | | | | Market shares in 2008 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Distance: | <200km | 200 to 800km | > 800km | all | all | <200km | 200 to 800km | > 800km | all | all |
| Weight: | trips | trips | trips | trips | km | trips | trips | trips | trips | km |
| Car | 77 | 62 | 17 | 68 | 56 | 76 | 37 | 15 | 56 | 42 |
| HSR | 0 | 19 | 12 | 8 | 14 | 2 | 24 | 42 | 13 | 26 |
| Other Rail | 21 | 11 | 9 | 16 | 12 | 21 | 31 | 9 | 25 | 20 |
| Bus | 1 | 2 | 7 | 2 | 2 | 1 | 2 | 0 | 1 | 2 |
| Air | 0 | 6 | 43 | 5 | 13 | 0 | 6 | 33 | 4 | 10 |
| Not answered | 1 | 1 | 11 | 2 | 3 | 0 | 2 | 0 | 1 | 1 |
| *Total* | *100* | *100* | *100* | *100* | *100* | *100* | *100* | *100* | *100* | *100* |

Sources: Insee, Transport and communication survey, 1994, and SOES, Transport and travel survey, 2008.
Note: Both surveys are collected at the household level.
In 2008, HSR travels account for 13% of all trips (26% when weighted by distance), while air travels account for 4% of all trips (10% when weighted by distance).

Table 2.10 also provides some information about market shares at an earlier period, 1994, which corresponds to the beginning of our period of observation. It shows that the extension of the HSR network and its wider availability was accompanied by large gains in market shares.

[46]Unfortunately, the sample size of the survey does not allow to analyze the break-down of managers' travels by distance in a statistically meaningful way, especially for the shortest trips. Therefore, we only provide a description of the aggregate of all business travels and assume that the discrete choice patterns of managers does not deviate too much from them (which for the longest trips at least is a reasonable assumption).

Figure 2.6: Market Shares of Rail and Air for the Passenger Market (Business and Non-Business), 1993 - 2011




Sources: compiled by SOeS - Ministry in charge of Transports from rail operators and DGAC.

This fact is further confirmed by figure 2.6, which shows that HSR traffic experienced a steep growth while traffic by air and standard rail did not increase much.

This large market penetration by HSR is consistent with the fact that HSR was adopted quickly by a significant share of professional users when it was introduced as a new transportation device.

### 2.A.3 Further evidence from the evolution of the airline industry

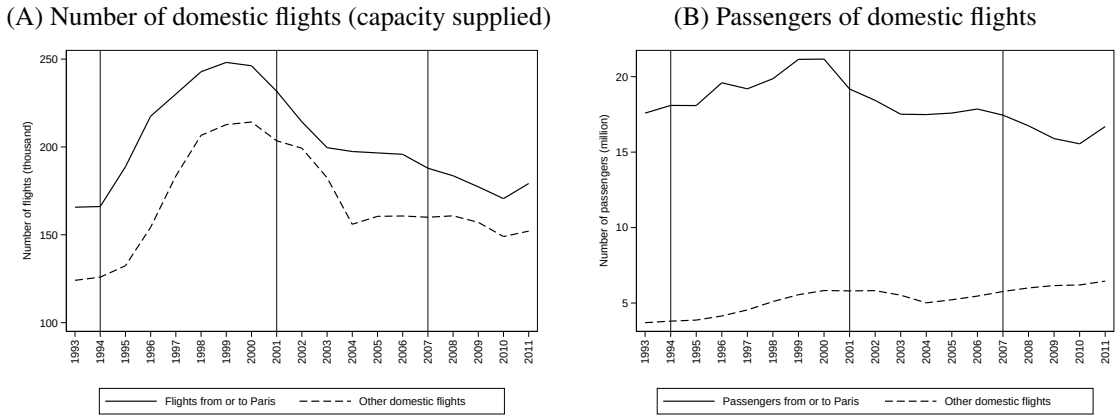
This section documents the aggregate evolution of the airline industry over our period of study: in spite of a structural liberalization episode between 1994 and 2000, the evolution of the industry did not affect massively the options available to managers for their business travels during the period.

The airline industry was marked by an important liberalization episode between 1994 and 2001[47], which witnessed the entry of several airlines on the French market (including the domestic market), and the global increase of the supply of domestic flights. This pattern is documented on figure 2.7, which shows that while entry (and the supply of new flights) increased steeply between 1994 and 2000 (panel (A)), the number of air passengers however did not follow the same pattern and remained almost stable over the period (panel (B)). Due to a lack of demand, the number of domestic flights decreased quickly between 2000 and 2004, to go back to the supply level of 1993. Figure 2.6 shows that in contrast, transport by rail experienced a

[47] For a description, see for example the report to the French Senate Senate (2001).

massive increase over the period, with implied volumes that are several orders of magnitude larger than total air traffic (as measured by total number of passengers, even when weighted by distance traveled).

Figure 2.7: Supply and Demand in the Airline Industry, 1993 to 2011




Sources: *Flux de Trafic Commercial (Commercial Traffic Flows), 1986 - 2013*, DGAC (published in June 2014).

These patterns are suggestive of the fact that in spite of the liberalization episode, airlines did not actually gain large market shares over other means of transportation, in particular rail. Figure 2.8 shows that there was no huge change in the relative price advantage of airlines over rail, neither over our period of analysis (given the parallel evolution of the two respective price indices), nor today (when comparing fares for selected destinations). Over the recent period, the number and frequency of connections by air is lower than the number and frequency of connections by rail, and many destinations served by HSR are simply not served by airlines.

## 2.A.4 Discussion of potential biases

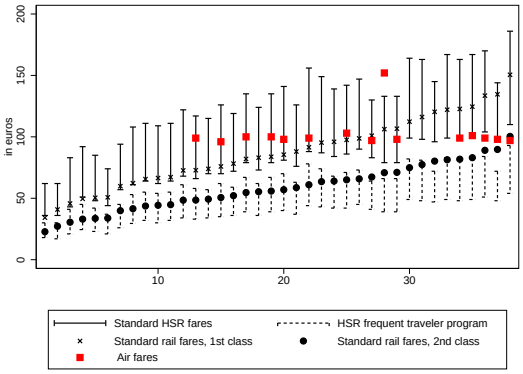
What is the likely impact of overlooking air connections in our computations of travel times? If anything, this should produce an attenuation bias, which we expect to be small given the previous developments. More precisely:

- Whenever managers use air connections (be they new or not) rather than rail, then HSR travel time reductions are irrelevant, which generates attenuation bias in our setting.
- When airline connections appear (resp. disappear), then managers' demand might reports to air (resp. rail) in absence of rail travel time reduction. Travel time might change

Figure 2.8: Prices of Transport by Rail and Air, between 1993 and 2011

(A) Aggregate Consumption Price Indices
Computed by the Statistical Institute
*(base year 1998)*


(B) Selected Prices Posted Online
as of March 2015
for 38 Destinations with Departure from Paris




Sources: Panel (A): French National Statistical Institute (Insee).
Panel (B): Online available prices as of March 2015, for 38 selected destinations (with departure from Paris) sorted by distance:
Reims, Arras, Le Mans, Tours (St-Pierre-Des-Corps), Lille, Valenciennes, Dijon, Angers St-Laud, Metz, Poitiers, Nancy, Mâcon-Loché TGV, Rennes, Besanon-Viotte, Nantes, Niort, Lyon Part-Dieu, Angoulême, Lyon St-Exupéry TGV, Strasbourg, La Rochelle, Mulhouse, Valence TGV, Chambéry Challes-les-Eaux, Annecy, Grenoble, Bordeaux St-Jean, Lorient, Brest, Avignon TGV, Nîmes, Dax, Aix-en-Provence TGV, Montpellier, Marseille St-Charles, Toulon, Toulouse-Matabiau, Nice. Air fares are retrieved from the website of Air France (Hop!), the leading airline company.

(increase or decrease) in absence of HSR travel time variation, which would also generate attenuation bias in our setting.

- When airline closures are related to HSR line openings, then actual travel time might decrease by less than what we compute, or even increase. This would also generate attenuation bias in our setting.
- Amplification biases could be generated by airline openings as *simultaneous* responses to the opening of new HSR lines, in association with shorter travel times by air than by rail. We however think that these events were relatively rare. Furthermore, these upward biases are most likely low if travel time achieved by HSR is close to travel time by air (including access to airport or train station, see the discussion in section 2.2).

## 2.B Details of the estimation method (Guimaraes and Portugal, 2010)

The principle of the estimation method is to iterate on three sets of normal equations that are conveniently defined. Let us first rewrite equation 2.2 in matrix format as:

$$\underbrace{Y}_{y_{ijlt}} = \underbrace{X\ B}_{\beta.T_{ijt}+\gamma.X_{(ij)lt}} + \underbrace{D_I\ A^I}_{\alpha_{ij}} + \underbrace{D_{LT}\ A^{LT}}_{\alpha_{lt}} + \underbrace{\epsilon}_{\varepsilon_{ijlt}} \tag{2.7}$$

where $X$ is a vector encompassing our *continuous* treatment variable and additional *continuous* explanatory variables (typically group exposure to international demand conditions, i.e. export intensity), $D_I$ is the vector of the affiliate level dummies $(\alpha_i)$, $D_{LT}$ the vector of the commuting zone $\times$ year dummies $(\alpha_{lt})$, $B$, $A^I$ and $A^{LT}$ are the corresponding parameters to be estimated. The three sets of normal equations are defined as follows:

$$\left( \begin{array}{c} B = (X'X)^{-1}X'(Y - D_I\ A^I - D_{LT}\ A^{LT}) \\ A^I = (D_I'D_I)^{-1}D_I'(Y - X\ B - D_{LT}\ A^{LT}) \\ A^{LT} = (D_{LT}'D_{LT})^{-1}D_{LT}'(Y - X\ B - D_I\ A^I) \end{array} \right)$$

The algorithm is initiated at $A^I_{(0)} = 0$ and $A^{LT}_{(0)} = 0$. The first of equation provides the first estimated value for $B_{(1)}$, which is plugged into the second set of equations to get $A^I_{(1)} = A^I_{(1)}\left(B_{(1)}, A^{LT}_{(0)}\right)$. Then $B_{(1)}$ and $A^I_{(1)}$ are plugged into the third set of equations to get $A^{LT}_{(1)}$. This procedure is iterated until the sum of squared residuals no longer decreases.

The benefit of decomposing the set of normal equations into the three sets above is that it renders the estimation computationally tractable. Only the first set of equations requires an actual matrix inversion, but it is of relatively low dimension. It can be performed by simple OLS on the modified dependent variable $Y - D_I\ A^I_{(n-1)} - D_{LT}\ A^{LT}_{(n-1)}$. The two last sets of equations simply correspond to the computations of means: of the variable $(Y - X\ B_{(n)} - D_{LT}\ A^{LT}_{(n-1)})$ by affiliate across years (classes generated by $D_I$), and of the variable $(Y - X\ B_{(n)} - D_I\ A^I_{(n)})$ by commuting zone $\times$ time across affilaites (classes generated by $D_{LT}$). This algorithm, which consists in iterating sequentially across each set of equations, falls into the class of so-called "partitioned" algorithms ("zigzag" iterations) which has been analyzed in full length by Smyth (1996): while the iteration process is slow in general (unless covariates are orthogonal, but this is not the case in our setting), the zigzag iteration is found to admit a global convergence result.

To compute the correct standard errors associated with the estimate of $B$, Guimaraes and Portugal (2010) apply a result derived by Abowd et al. (2002), who show that the total number of identified "fixed" effects is given by $N^I + N^{LT} - G$, where $G$ is what they call (in their application) the number of "mobility groups" (classes) generated by the two sets of fixed effects, $D_I$ and $D_{LT}$. In our case, this simply corresponds to the partition by geographical zones, i.e. $G = L$. The formula for the computation of standard errors is then given by:

$$V(\widehat{\beta}) = \frac{SSR}{(N - N^X - N^I - N^{LT} + L).N.s^2_{\text{time}}.(1 - R^2_{\text{time}})}$$

where $N$ is the total number of observations, $N^X$ is the number of variables in $X$, $N^I$ is the number of affiliates and $N^{LT}$ is the number of commuting zones $\times$ time. Last, $s^2_{\text{time}}$ is the sample variance associated with the travel time variable and $R^2_{\text{time}}$ is the coefficient of determination obtained from a regression of travel time on all other remaining explanatory variables.

## 2.C Details of the French classification of occupations

Table 2.11: French Classification of Occupations

| Code | Description of Occupation |
|---|---|
| 2 | Heads of businesses |
| 34 | Science and educational professionals |
| 35 | Creative professionals |
| 37 | Top managers and professionals |
| 38 | Technical managers and engineers |
| 42 | Teachers |
| 43 | Mid-level health professionals |
| 46 | Mid-level managers and professionals |
| 47 | Technicians |
| 48 | Supervisors and foremen |
| 53 | Security workers |
| 54 | Office workers (clerks) |
| 55 | Retail workers |
| 56 | Personal service workers |
| 62 | Skilled industrial workers |
| 63 | Skilled manual laborers |
| 64 | Drivers |
| 65 | Skilled transport and wholesale workers |
| 67 | Unskilled industrial workers |

## 2.D Computation of rail travel times

This section describes the construction of rail travel times between headquarters and affiliates. We relied on a two-step procedure:

- First, we simplify the network of trains stations and select only one "main station" by commuting zone.
- Second, we collected and constructed time tables for the resulting list of 316 stations.

Rail travel time between an affiliate and its headquarters is then measured by rail travel time between the respective "main stations" of the commuting zones where they are located. Travel time between headquarter or affiliate and "main station" is neglected for two reasons:

- It is typically short, and it does not vary over time (while our identification strategy typically relies on *variations* in travel times - see section 2.3).
- Furthermore, managers who are asked to travel for professional reasons might depart from home rather than from work: in such cases, travel time between headquarter or affiliate and "main station" is not the relevant quantity. In absence of precise information about the location where managers live, and from which station they might depart, the main

station in each commuting zones is by construction[48] the best statistical guess we can get about it.

This fact therefore also motivates our choice to allocate each headquarter and affiliate to the main station in their commuting zone, although the alternative of choosing the closest station is discussed in detail in section 2.D.3 below (it does not make much difference since the two candidate stations under each alternative are typically very close).

### 2.D.1 Selection of the "main station(s)" in each commuting zone

We select a set of 316 "main stations", among the set of stations which existed in 1993, using the following criteria:

- In cases where only one station in the considered commuting zone is served by HSR, we select it as its "main station".
- In cases where several stations in the considered commuting zone are served by HSR, we select the station having the highest long distance traffic using an adequate score based on the number of long distance services that are available in each station.[49]
- In cases where none of the stations in the considered commuting zone is directly served by HSR, we select the station having the highest long distance traffic score.
- In the rare cases of ties, we select the station located in the most populated municipality.
- Stations that were specifically built to accommodate HSR services during our period of estimation replace the previous "main station" in their employment zone from the date they enter into service.
  Overall, these "new HSR stations" have a large impact on rail travel times.[50]

### 2.D.2 Time tables between "main stations"

We then collected past and current timetables in order to recover the fastest train service between any two directly connected "main stations":

[48]Commuting zones are defined "as the geographical area within which most of the labor force lives and works, and in which establishments hire most of their workforce".

[49]To be more precise, we computed traffic scores as of 2013 (for data availability reasons), based on the total number of services available in each station, but giving less weight to services with many local stops. The score is computed as the sum of the squared average distance between any two consecutive stops for each service available in the considered station.

[50]Which legitimates the investment required by their construction...

- Travel times for train services which remained "local" over the entire period (i.e. those implying no HSR service) were simply approximated by the 2013 timetables, which are available on the open-data platform of the national rail company.

- For long distance services, we relied on rail fan web sites and the archives of the national rail company, as well as on the evaluation reports of the French Ministry for Transportation (LOTI reports). These sources enable us to assess train travel times both *before* and *after* HSR line openings.

The obtained database contains travel times between any two directly connected stations, at any date between 1980 and 2013[51]. We then complement it with travel times between any two *indirectly* connected stations, assuming that each train change takes 15 minutes (a rather lower bound).

### 2.D.3 Discussion

In table 2.12, we compare travel times obtained with our baseline procedure, where we allocate each affiliate or headquarter to the main station in their respective commuting zone, with an alternative procedure where we allocate each affiliate or headquarter to the closest main station (not necessarily located in the same commuting zone). The main take-away of this table is that *absolute* travel times are somewhat altered by this alternative choice of measurement, since the average discrepancy for treated affiliates is 12 minutes (while the median is only 2 minutes). However, *changes (reductions)* in travel times are far less affected, since they only occur via new HSR line openings and therefore fundamentally rest on stations served by HSR, which are the same in the two procedures. The precise distribution of these changes in our estimation sample is plotted on figure 2.9.

[51] This time span encompasses our period of analysis and enables us to run the "placebo" robustness checks presented in section 2.5.

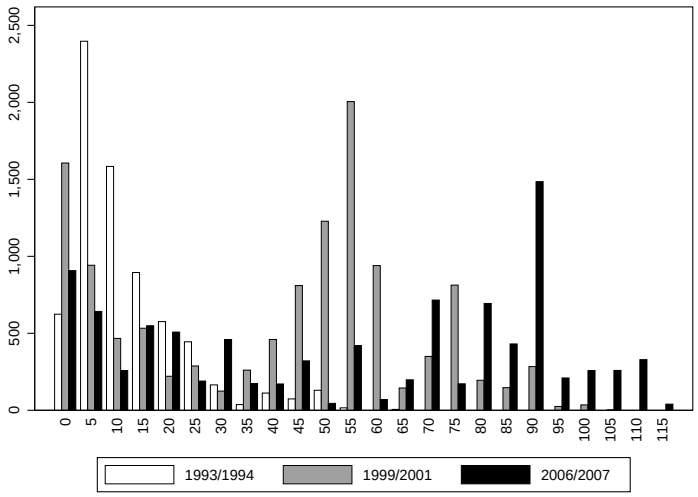
Table 2.12: Travel Times with Alternative Computing Procedures

| **Affiliates × years** | **No travel time change in our sample** | | | **Reduction in travel time in our sample** | | |
|---|---|---|---|---|---|---|
| Computation of travel time from/to: | Com. Zone | Closest | Difference | Com. Zone | Closest | Difference |
| Distance to HQ (km) | 160 | | - | 450 | | - |
| HQ in Paris | 29% | | - | 36% | | - |
| *Comparison of computing procedures:* | | | | | | |
| Same zone (station) as HQ | 42% | 40% | (4%) | 0% | 0% | (0%) |
| Travel time after change (minutes) | 95 | 98 | 7 | 232 | 240 | 12 |
| Variation in travel time (minutes) | 0 | 0 | 0 | 35 | 32 | 6 |
| Share of firms with travel time change | 0% | 0% | (0%) | 100% | 81% | (19%) |
| Share of aff. benefiting from HSR service | 33% | 32% | (2%) | 100% | 96% | (4%) |
| Share of new HSR users | 0% | 0% | (0%) | 19% | 16% | (5%) |
| Direct track | 72% | 68% | (7%) | 47% | 37% | (13%) |
| 1 change | 14% | 16% | (8%) | 25% | 26% | (16%) |
| 2 changes or more | 12% | 15% | (4%) | 28% | 37% | (11%) |
| Nb observations (affiliates × year) | 4,739,655 | | | 63,769 | | |

Sources: Matched DADS files and LIFI survey; affiliates (see section 2.2.1 for definition) which are part of multi-location groups between 1993 and 2011.
Notes: The classification in columns between affiliates × years experiencing (or not) changes in travel times is based on the computation of travel time between commuting zone which is actually used in our regressions. Notice that around 40% of the affiliates × years experiencing no change in travel time are located in the same commuting zone as their headquarters. For the 60% which are not located in the same commuting zone as their headquarters: average distance to HQ is 273km, average travel time (between employment zones) is 162.3 minutes, and the share of direct tracks (between employment zones) is 52.5%.

Figure 2.9: Distribution of travel time reductions at main dates of HSR line openings

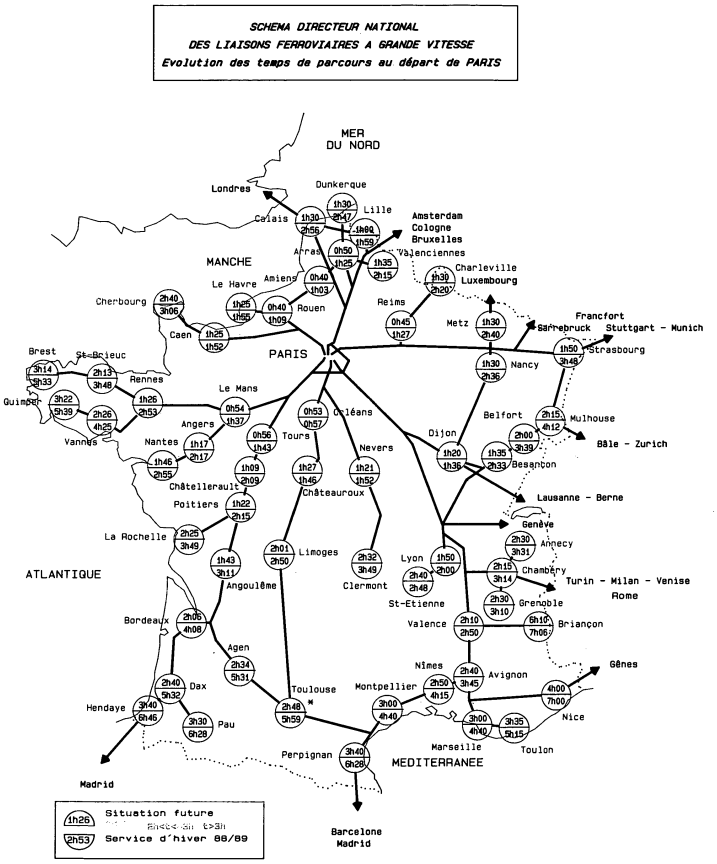
*Northern line (1993/94), connection to Marseille (2000/01) and Eastern line (2006/07)*




Sources: Matched DADS files and LIFI survey; affiliates (see definition in section 2.2.1) which are part of multi-location groups between 1993 and 2011.
Note: Values are expressed in minutes. Firms which did not experience any change in rail travel time at the respective dates were excluded: observations in the bin labeled by "0" correspond to strictly positive travel time reductions, but that are smaller than 5 minutes.

# 2.E Map from the 1991 Governmental Blueprint Document

Figure 2.10: Map of the HSR Lines Proposed in the 1991 Governmental Blueprint Document



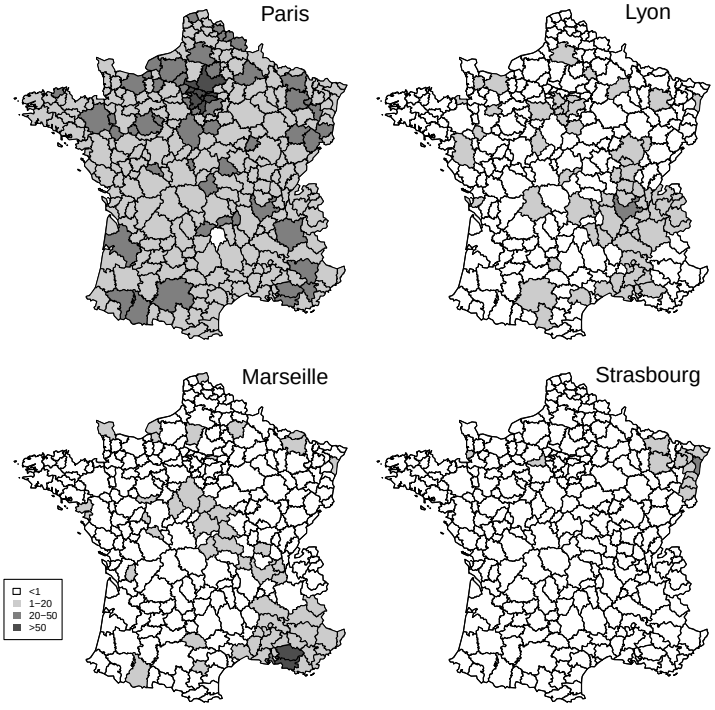

Sources: Ministère de l'Équipement (1991), French Ministry for Equipment.

# 2.F Remote corporate control in France: the disproportionate weight of Paris

Figure 2.11 provides a break-down of the indicator of figure 2.2 (section 2.2.1) and describes in each commuting zone, the share of employment under control of HQs located respectively in Paris, Lyon, Marseille or Strasbourg. The main take-away of this comparison is the disproportionate weight of Paris in terms of corporate control. In terms of geographical range, the map shows that its sphere of "corporate influence" is particularly wide ranging, since most of the territory is reached by Parisian headquarters. Lyon and Marseille also reach very distant areas, but only occasionally and with a lower weight in terms of local employment.

Figure 2.11: Sphere of "Corporate Influence" of 4 of the Largest French Cities, in 2011

*Share of private employment in each zone that is under control of HQs located in the respective cities in percentage of total private employment (except agriculture and personnel services)*

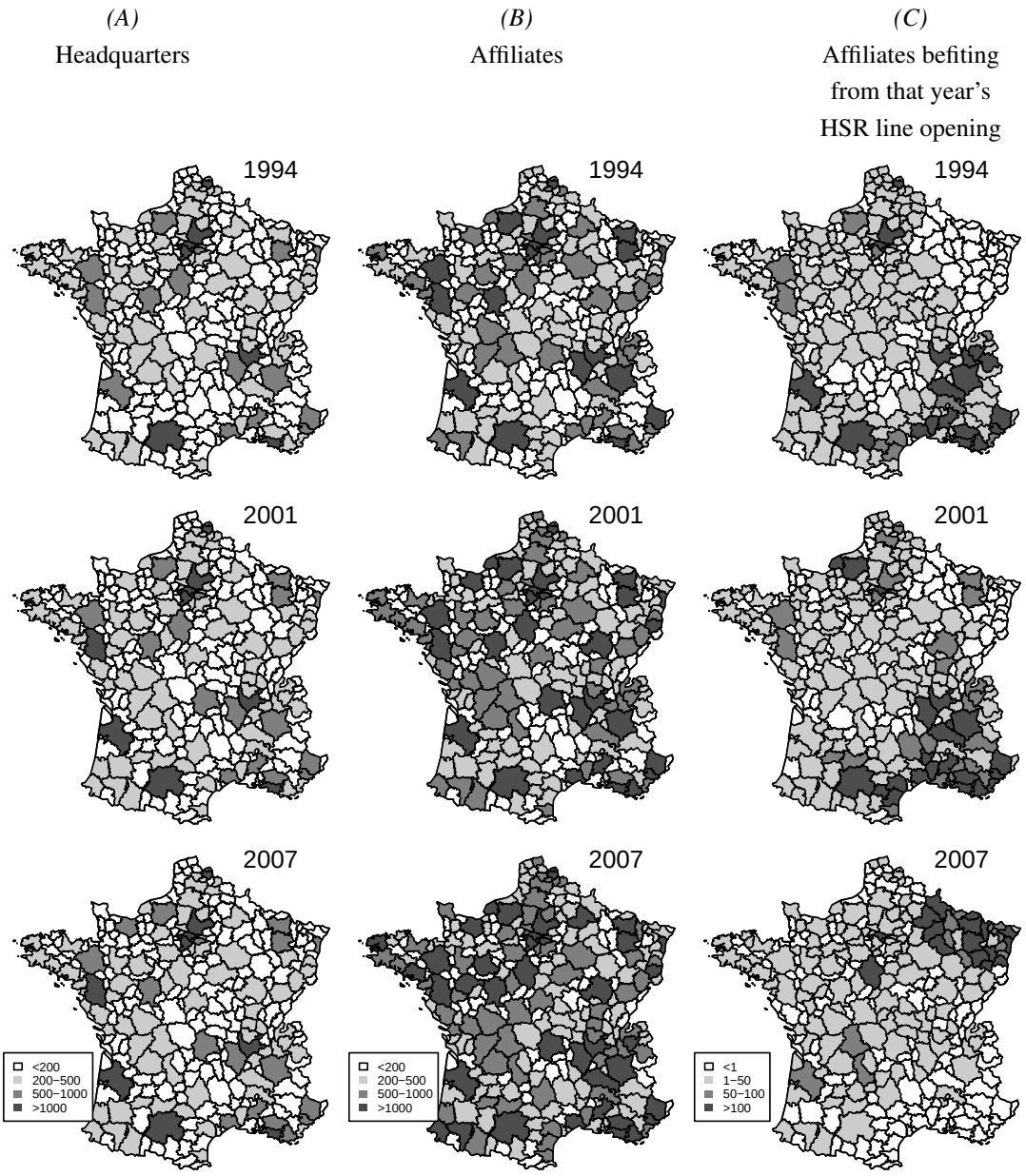



Sources: Matched DADS files and LIFI survey, covering the private sector (except agricultural activities and workers of the personnel service industries directly employed by households).
Notes: the four maps describe the share of private employment in each "employment zone" that is under control of HQs located, respectively, in Paris, Lyon, Marseille or Strasbourg (i.e. the sphere of "corporate influence" of these four large French cities.

# 2.G Geographical distribution of the estimation sample

Figure 2.12: Localization of Business Units Benefiting from Rail Travel Reductions

*Estimation Sample (Population)*




Sources: Matched DADS files and LIFI survey; business units (HQs or affiliates - see section 2.2.1 for definition) which are part of multi-location firms between 1993 and 2011.
Note: The different dates correspond to the opening date of the Northern line (1993/1994), of the connection to Marseille (2000/2001) and to the opening date of the Eastern line (2006/2007).

# Part II

# Wage inequality by skills, labor demand and local labor markets : evidence from France

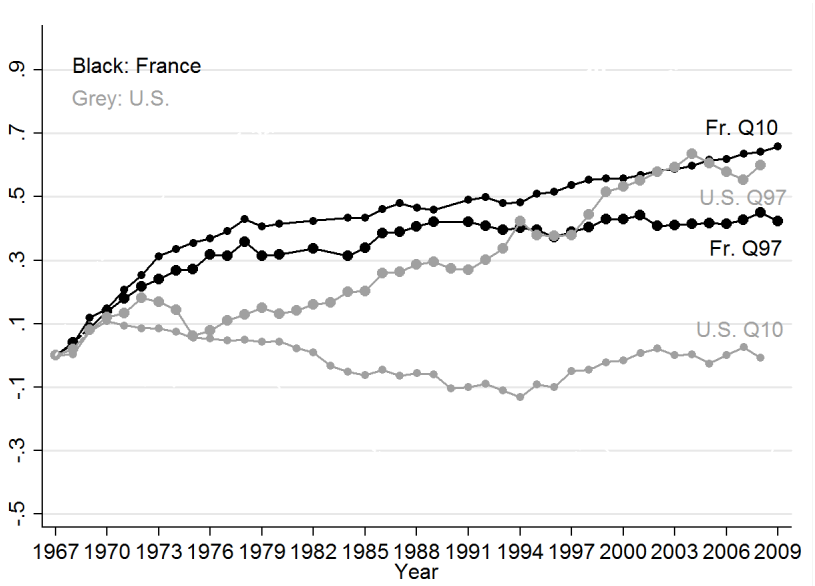
# Chapter 3

# Wage inequality and the labor demand by skills in France : national trends and spatial dynamics

# Introduction[1]

Wage inequalities have increased a lot in the US since the 1980s (see, e.g., Goldin and Katz (2008), Juhn et al. (1993), Card and Lemieux (2001)), giving birth to a broad literature on wage inequalities and, in particular, on wage inequalities by skills. This literature relates the relative wage of college-educated workers with respect to workers who completed high-school, to the evolutions of the education level of workers (see $e.g.$ Katz and Murphy (1992), Acemoglu (2002), Autor et al. (2008), Acemoglu and Autor (2011)). Since, both the relative supply and wage of college educated workers increased in the US during that period, this entails a rise in the relative demand for college educated workers or, in other words, a skill-biased shift in labor demand. Main explanations proposed for the skill-biased shift in labor demand in the US are market factors such as technical change and globalization. These factors are common to developed economies such as France and it is likely that they also impacted their labor demand. But, in France, there has been no such increase of wage inequalities by skills (Verdugo (2014) and figure 3.1). We thus investigate in this chapter whether the decreasing wage inequalities by skills in France have hidden a skill-biased shift in labor demand.

Figure 3.1: France/U.S. Comparison: Cumulative Log Changes in Real Weekly (U.S.) and Real Daily (Fr) Wages since 1967.




Source: France: DADS-EDP data. 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, Weighted by Job Duration. U.S.: Full-Time Full-Year Male Workers, from Acemoglu and Autor (2011);

[1]This chapter is based on a joint work with E. Coudin and M. Gaini and a joint work with M. Orand.

A part of the literature documented this skill-biased demand shift and its causes in other countries than the US. The U.K., Canada, Germany, and Portugal do yield evidence in favor of a skill-biased demand shift. Over the 1980s and the 1990s, skill premiums and residual inequalities increased in these countries but with varying degrees of strength, see $e.g.$ Card and Lemieux (2001), Dustmann et al. (2009), Machado and Mata (2005). For France, this skill-biased shift in demand has not been much studied and probed. Goux and Maurin (2000) provided some evidence of a skill-biased shift in France between 1970 and 1993, of a smaller extent than in the U.S. Studies on panel of European countries including France also provide some results. Machin and Van Reenen (1998) used a panel on seven OECD countries between 1973 and 1989, including France, and found a significant association between skill-upgrading and R&D intensity. They concluded that skill-biased technical change is an international phenomenon. Goos and Manning (2009), studying the distribution of employment between occupations in Europe, found evidence of job polarization in France between 1993-2006. Polarization is the fact that the demand for jobs at the bottom and top of the wage distribution increases while the demand for jobs in the middle of the wage distribution decreases. It can be viewed as a refinement of the hypothesis of a skill-biased demand shift. This could explain increasing wage inequalities by skills if low-skilled workers move from jobs in the middle of the wage distribution to jobs at the bottom.[2]

Hence, evidence for France is limited to some periods or to some dimensions. We propose a broad picture of the trends in the supply, demand and wages of high-skilled workers relatively to low-skilled between 1967 and 2009 in France. We use annual linked employer-employee administrative panel data (*DADS panel*) matched with the census sample database (*échantillon démographique permanent*), which yields high quality information on wages and education.[3] We focus on full-time private sector workers and the analysis is restricted to male in order to limit labor market participation issues.[4] We document a strong decrease in wage inequalities over 1967-2009, even stronger once we control for composition changes in education and experience. The high-skilled/low-skilled wage gap strongly decreased over the period, along with a strong increase in the high-skilled workers relative supply. Then, we use a supply and demand model *à la* Card and Lemieux (2001) to estimate demand effects on the high-skilled/low-skilled relative wage and we find that there has been a skill-biased demand shift in France and that it has an upward effect on the relative wage of high-skilled workers with an order of magnitude between half and 100% of what is found in the U.S. It means that if there has not been an in-

[2]But Goos and Manning (2009) did not relate it to wages.

[3]The wage information is compulsorily reported by firms to social and fiscal organizations to compute social contributions and pensionable earnings.

[4]Papers in the literature run separate regressions for men and women (see Lemieux (2006) or Autor et al. (2008)) or focus only on men (Dustmann et al. (2009)).

crease in the supply of high-skilled workers, the wage gap between high-skilled and low-skilled workers would have increased. We then run some simulation exercises using our estimated parameters to compute projections of wage inequalities by skills up to 2030. We find that under reasonable assumptions, wage inequalities may increase in France in a similar way as already happened in the US.

This chapter is organized as follows. Section 1 describes the data and section 2 the trends in labor supply and wages by skills in France over the last forty years. In Section 3, we present the empirical strategy to test for the presence of a skill-biased shift in demand and in section 4 the results. Section 5 is dedicated to a robustness analysis of our results with respect to issues of selection into employment and labor cost. Section 6 proposes complementary results by extending the analysis to local labor markets and testing whether the skill-biased shift in labor demand is homogeneous across local labor markets.

## 3.1 Data

We use the panel subsample of the *Déclarations Annuelles de Données Sociales* (DADS) matched with the Census, *Echantillon démographique permanent* (EDP) dataset.[5] The analysis is conducted from 1967 to 2009, except for 1981, 1983, 1990 (years for which wage data are unavailable) and 1994 (because of poor quality data).

The DADS is an exhaustive administrative database of annual employer-employee wage bill information with compulsory completion by any firm. It contains information on wages, working periods and the private sector employers of wage earners born at chosen dates. The panel DADS is a subsample extracted from the DADS for scientific use.

The EDP database collects census information – e.g. education at the census dates – and civil status administrative information for a sample of the population of France. Since 2004, the exhaustive French population census, which used to be carried out once a decade, has been replaced by annual census surveys, in which nearly 10% of the population are interviewed. We use the data from the exhaustive population censuses of 1968, 1975, 1982, 1990, 1999 and the census surveys for 2004 to 2009. Hence among young cohorts, that is, individuals who finished their studies after 1999, the last exhaustive census year, the education level is only known for individuals interviewed by at least one census survey after the end of their studies. This concerns approximately 80% of those who ended their studies between 1999 and 2004, but only 13% for

[5]Those databases are produced by INSEE (French National Institute of Statistics and Economic Studies).

the ones who finished in 2008. So, we weight the observations concerning those individuals to avoid a deformation of the per-year population structure.[6]

**Sample.** The analysis is restricted to 15- to 64-year-old male wage earners working full-time in the private sector and born in France. To ensure that the wage distribution is representative of the total number of days worked in the economy, the working periods are weighted by the number of working days which they report. Working periods corresponding to internships and apprenticeships are excluded from the analysis because their remunerations are often fixed by law and do not reflect an evaluation of skills. We also exclude intervals of work while studying because the level of education attained at this point is unknown. Finally, our sample contains approximately 40,000 observations per year between 1967-2009.

**Wage, education, and experience.** The variables used in the analysis are the wage, the highest degree obtained (education), and the experience accumulated as a wage earner in the private sector. The wage and experience variables are constructed using the information from the DADS panel and the education variables from the EDP dataset.

The **wage variable** is the real (deflated by the consumer price measure) net (social contributions excluded) daily wage in 2009 euros, $i.e.$, the sum of net earnings (including all one-shot remunerations paid during the year) for a given job spell, divided by the number of working days for that given job spell. The DADS wage information is used by the social security and fiscal organizations. This ensures the data quality in comparison to self-reported wage information from survey data such as the Labor Force Survey, which may suffer from declaration bias. More precisely, wages and bonuses are totally covered. Profit sharing and wage-saving schemes are covered, but only for the portion immediately paid to the worker.[7] This may be a limitation,

[6] We obtain weights for the individuals who ended their studies after 1999 and for whom information about educational degrees has been collected – $i.e.$ who were interviewed by at least one census survey after the end of their studies – in the following way. First, note that the school-leaving year is not observed; we only know whether or not an individual completed his/her studies at the date of the census survey. So we simulate a school-leaving year for each individual, calibrated on the school-leaving year distribution by degree and cohort observed in the Labor Force Survey. Then, for each individual with the same school-leaving year, we invert the sampling probability of being interviewed in at least one annual census survey after that school-leaving year. For instance, those who finished their studies in 2000 are weighted by one over the probability of being interviewed in at least one census survey between 2004 and 2009, and those who finished in 2006, by one over the probability of being interviewed at least once in the census survey 2007 to 2009. The weighted distributions of degrees per cohort obtained in our data do not differ from those observed in the Labor Force Survey.

[7] In 2010, 49% of the employees of firms of more than 10 employees received some income from profit sharing schemes, for an average of 6.9% of wages. Profit sharing schemes include "intéressement", and "participation". The "intéressement", created in 1959, is optional but its coverage increased greatly in the end of the 1980s (590 000 covered workers in 1986, and 2 millions in 1990). The "intéressement" equals 3%-4% of the wages. The "participation", created in 1969, is mandatory for firms of more than 100 employees, and more than 50 employees

especially for the recent years, during which these remuneration schemes have grown. However, the amounts involved are still quite modest, and usually proportional to wages (Amar and Pauron (2013)).

The **education variable** indicates the highest degree obtained at the end of studies. We follow Abowd et al. (1999) and construct seven groups of educational attainment: no degree reported or elementary school level, junior high-school degree, basic vocational degree, advanced vocational or technical degree, high-school degree (BAC), some college (BAC+1, BAC+2) and university degree (BAC+3 and more). The French labels for education groups are detailed in Table 3.5 in the Appendix, together with their shares in the panel population.[8]

The **experience variable** refers to the experience accumulated as a wage earner in the private sector. It is constructed as the sum of the shares of working days per year from a given individual's first appearance in the DADS panel up to the current working period.[9]

## 3.2 National trends in wage and labor supply by skills

In this section, we document trends in labor supply and wage by skills in France on the period 1967-2009. Up to now, due to data limitations, there has been in fact not much evidence for France on wage inequalities by education level over such a long period.

### 3.2.1 The democratization of education and the rise of high-skilled workers supply

From 1967 to 2009, the composition of the French male labor force changed dramatically. The education level vastly increased: the share of workers with no diploma decreased from 62% in 1967 to 18% in 2009. Older – and less educated – workers were gradually replaced

since 1990 but the design of the scheme is firm-specific. It has also expanded since 1986. The participation amount is not immediately paid out to the worker; it stays in a blocked account for 5 years.

[8]Declared education may differ between censuses. We favor the information in the census that was declared directly after the end of studies or after having turned 27. The idea is to minimize potential memory bias. When no degree is declared in that census, we use the information reported in the following ones. Individuals whose information is still missing after these procedures are excluded from the analysis.

[9]Before 1976, the DADS panel is only available for a subsample of individuals. So, we assume that individuals present in the DADS in 1976 or before with a school-leaving year anterior to the year of first appearance, were employed between the end of their studies and their first appearance in the panel. We argue that this is not a strong assumption because unemployment and part-time work were not frequent in the 1960s-1970s, especially for men. Furthermore, the DADS data is missing for 1981, 1983 and 1990. To correct the experience variables for the following years, we average the shares of working days per year for the year just before and for the year just after the missing year and we add this average to the experience variable.

by more educated new cohorts due to a succession of pro-education policies: first, increases in the minimum school-leaving age, which was raised from 12-13 to 13-14 years-old in 1936, and from 14 to 16, in 1959; [10] second, a strong drive to promote the democratization of education, which gradually took effect from the 1960s to the 1990s at each level of education. In the 1960s, in connection with the increase in the school-leaving age, access to Junior/Basic degrees became much more common: 40% of new labor market entrants held a basic vocational degree in 1967, as shown in Figure 3.2. This share remained stable until 1990. Since 1990, changes in the level of education in the labor force have principally come about through expanding shares of high-school, advanced vocational and post-secondary degree holders. Once more, a political impulse led to these evolutions. In the mid-1980s, the government promoted the national objective of bringing 80% of a cohort to the baccalaureate level, $i.e.$, up to the completion of general or vocational high-school training. A new vocational high-school degree was created, the "Baccalauréat professionnel". In the 1990s, the share of new entrants with a basic vocational degree decreased, and the share with this advanced vocational one rose. The passing rate of the Baccalaureat also increased from 65% at the beginning of the 1980s to 73% at the beginning of the 1990s. This eased access to post-secondary education. The share of labor market new entrants with post-secondary education, either some years of college or a university degree, doubled from 1989 to 2000 (17% in 1989 versus 32% in 2000).

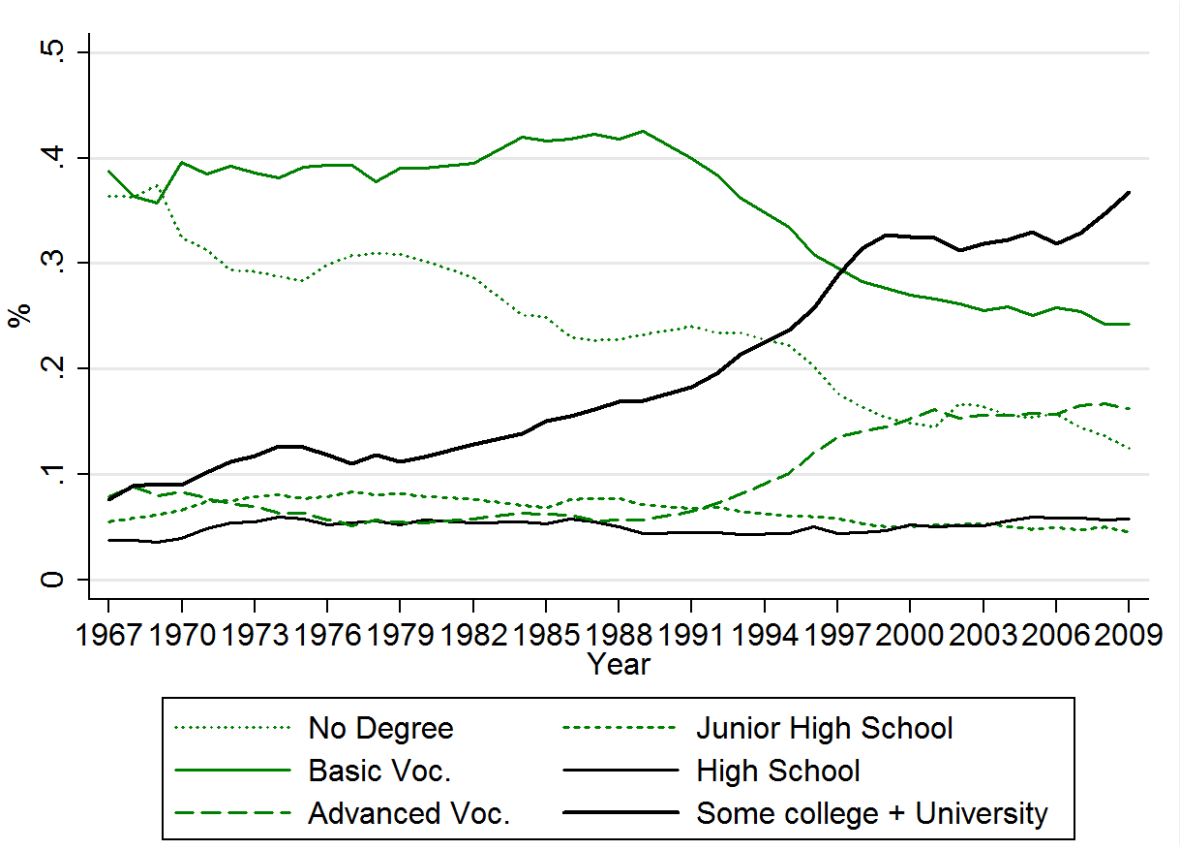
### 3.2.2 Decreasing wage inequalities

Figure 3.3 shows that the overall wage inequality among private-sector full-time male workers declined in France from 1967 to 1973 and has been declining again since the 1990s, whereas it remained stable in between. From 1967 to 2009, the Q90-Q10 log wage difference decreased by 0.17. In terms of wage levels, the Q90 wage was 3.5 times (=exp(1.26)) higher than the Q10 in 1967, whereas in 2009, it was 3.0 times higher. In comparison, in the U.S. over the same period, the Q90-Q10 weekly log wage difference of full-time male workers increased by approximately 0.4, and the hourly log wage difference respectively by approximately 0.2.[11] Figure 3.3 also shows the evolution of wage inequality keeping the 1967 labor force structure by education and experience groups on the whole period. The decrease in wage inequality is dramatically more pronounced once we control for skill-composition changes. Wage inequality only plateaued during the 1980s. Moreover, the decrease in wage inequality was driven by

[10] Before 1936, individuals could quit school at 12 if they had completed a *certificat d'étude*, 13 if not. After 1936, both minimum leaving school ages were increased by one year. The Berthoin reform in 1959 established a sole legal minimum school leaving age of 16.

[11] Similarly, the Gini coefficient (for annual earnings in commerce and manufacturing) increased from 0.4 to 0.5 in the U.S., whereas it slightly decreased from .32 to .29 in France.

Figure 3.2: New entrants on the labor market : shares by education of full-time male Workers with less than five years of experience.




Source: EDP-DADS data. 15 to 64-Year-Old Full-Time Male Workers in the Private Sector with less than 5 Years of Experience, weighted by Job Duration.

decreases at both tails of the wage distribution. Inequalities decreased at a constant pace at the bottom half of the distribution during the whole period (Q50/Q10). For the top half of the distribution (Q90/Q50), raw inequalities declined only at the very beginning of the period and since the mid-2000s. When controlling for skill composition, inequalities at the top half of the distribution decreased on the whole period, with a sharp acceleration since the 1990s.

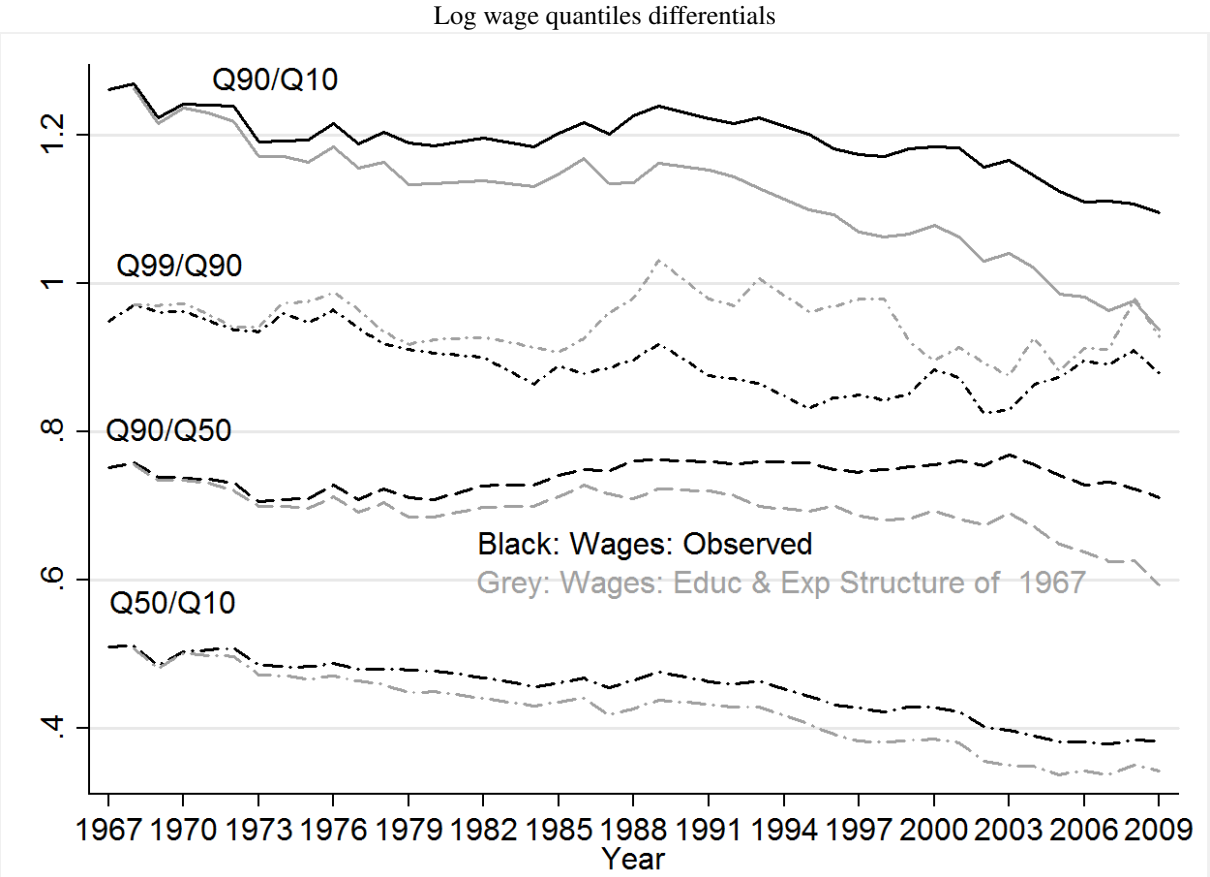
These trends in wage inequalities are in sharp contrast with the US ones but the evolution of the very top wage inequalities slightly balances the picture. Amar (2010) and Landais (2008) show that the wage growth rate of the top 1% of wage earners has dramatically increased since the end of the 1990s. The Q99-Q90 log wage differential reported in Figure 3.3 has indeed increased since the mid-2000s, but in a moderate way. This phenomenon has therefore been, and remains at present, more concentrated than the comparable case in the U.S. or the U.K. Godechot (2012) finds that it concerns mainly the top 0.1% and that the finance sector is responsible for half of the rise in inequality.

The increasing top wage inequality trends in the U.S. have been explained by the increasing relative wage of high-skilled workers with respect to low-skilled workers (some college and university wrt high-school). In France, the decrease in top wage inequalities is concomitant with a decrease in the relative position of high-skilled workers (some college and university wrt high-school), especially for low-experience groups, as shown in figure 3.4 which displays median wages by education level at 1 and 25 years of experience.[12] More precisely, wages increased quite uniformly across education and experience groups from 1967 to the beginning of the 1970s. Since then, group patterns have diverged. For low-experience workers, wages were stable during the 1970s except for university degree holders, who experienced a decrease. Changes were rather similar for all education groups in the 1980s but, since the mid-1990s, the gap between the university group and the high-school group has decreased. Among more experienced workers, wages of both university and high-school graduates decreased between the mid-1970s and the mid-1990s, and then remained stable. Figure 3.4 also reports other group wages: advanced vocational degree, basic vocational degree, and no degree at all, which follow trends similar to the wages of high-school graduates.[13]

[12] As a given education and experience group may not contain enough observations in a given year, we use estimated median wages for each group. We estimate a Least Absolute Deviations (LAD) regression model, in which education group dummies are interacted with experience (in years) up to a third-order polynomial to allow for different education-group-rewarding profiles of experience, and to account for the non-separability of these two human capital types.

[13] The cases of junior high-school (very similar to basic vocational) and some college (very similar to university) degree owners are not reported, for readability.

Figure 3.3: Log wage inequality trends : observed and adjusted for education and experience composition



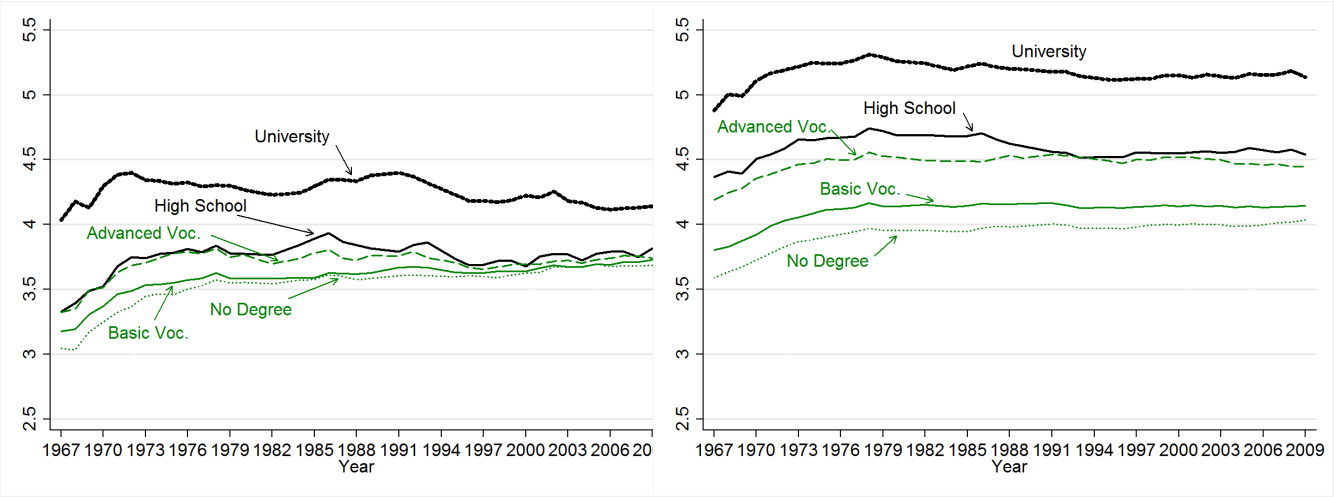

Source: EDP-DADS data, 15 to 64-year-old full-time male Workers in the private sector, weighted by job duration.

Note: Observed differentials of log wage quantiles are reported in Black. Differentials of log wage quantiles with 1967 Education and Experience Structure are reported in grey. The latter are obtained with the reweighting method of DiNardo et al. (1996). Weights are computed with a logit specification involving education group dummies interacted with experience, experience$^2$, and experience$^3$.

Figure 3.4: Median log daily wages by education and experience levels

(a) One Year of Experience

(b) 25 Years of Experience




Source: EDP-DADS data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Note: Median Log Wages obtained by year-by-year- Least Absolute Deviations (LAD) regressions of Log Wages on Education Dummies interacted with Experience, Experience$^2$, and Experience$^3$. The cases of junior high-school (very similar to basic vocational) and some college (very similar to university) degree owners are not reported, for readability.

## 3.3 Empirical strategy

In France, as the supply of high-skilled workers relatively to low-skilled workers increased, it is consistent to find that, contrary to the US, their relative wage decreased. However this evolution may nevertheless hide evolutions of the labor demand by skills. Hence, we now turn to the demand side and estimate whether the dynamics of the demand for high-skilled workers relatively to low-skilled workers have been similar between the US and France. In that case, potential explanatory factors common to both countries should be first investigated while in the opposite case, institutional factors might be more relevant. In this section, we detail the empirical strategy used to test for the presence of a skill-biased shift in labor demand in France between 1967 and 2009. We focus on skills measured by education levels, although experience, the second component of the Mincer equation, is also a major skill. But the level of experience of the 15-65 year old male is quite stable on the period as an increase in the length of studies and in unemployment occurred concomitantly to the aging of the labor force (Charnoz et al. (2011)). Since the evolution of labor supply by education is much stronger, the analysis focuses on education levels and only controls for experience levels. More results on the evolutions of experience premiums can be found in Charnoz et al. (2011). More precisely, we analyze university and college groups, versus high school and less than high-school groups. In the US,

low-skilled workers are high-school drop-outs but in the French context, it is more relevant to include also workers with only a high-school degree. Either they graduate with a vocational high-school degree, which is considered low-skilled on the labor market or with a non vocational high-school degree which is not much valued on the labor market if not followed by post secondary education. Moreover, less than high school group wages are closely connected to the minimum wage, whereas it is much less the case for more educated groups.[14]

### 3.3.1 Aggregate supply and demand model

We follow the setting of Card and Lemieux (2001), Autor et al. (2008), Acemoglu and Autor (2011), among others. It derives relationships between labor supply, demand and wage by skills from a production function at the national level. Parameters of interest are then estimated empirically using mostly time variations.

More precisely, we assume an aggregate constant elasticity of substitution (CES) production function, with two factors, high-skilled labor ($H$), $i.e.$ college and university graduates, and low-skilled labor ($L$), $i.e.$ high-school or less than high-school graduates. [15] The model extends Katz and Murphy (1992) and allows for imperfect substitution between different groups of experience within an education group by introducing two sub-aggregate CES forms:

$$Y_t = \left((A_{Lt}L_t)^{\rho} + (A_{Ht}H_t)^{\rho}\right)^{1/\rho}, \tag{3.1}$$

$$\text{with} \qquad L_t = \left(\sum_j \alpha_j L_{jt}^{\eta}\right)^{1/\eta} \quad \text{and} \quad H_t = \left(\sum_j \beta_j H_{jt}^{\eta}\right)^{1/\eta} \tag{3.2}$$

where $L_{jt}$ and $H_{jt}$ are the quantities of low-skilled ($L$) and high-skilled ($H$) belonging to the group of experience $j$, observed at period $t$. We consider four groups of experience: 0-9, 10-19, 20-29, and 30-39 years of real experience. Parameters $\alpha_j$ and $\beta_j$ are the relative efficiency parameters between the labor of different experience groups. They are assumed to be constant in time. $A_{Lt}$ and $A_{Ht}$ are the factor-augmenting technology terms of period $t$ for each skill group. Finally, the elasticities of substitution between labor types are accounted for by $\rho$ and $\eta$. $\rho = 1 - 1/\sigma$, where $\sigma$ is the aggregate elasticity of substitution between high-skilled and low-skilled labors. $\eta = 1 - 1/\sigma_E$, where $\sigma_E$ is the partial elasticity of substitution between different experience groups within the same education group. $\sigma_E$ is assumed to be equal in the

[14] See Charnoz et al. (2011) and Verdugo et al. (2012) who related the decrease in the bottom half French wage inequality to minimum wage increases.

[15] It might be more accurate to label them as high-educated and low-educated but we choose to use the most common terminology of the literature.

two education groups. Deriving the marginal products of each type of labor and equaling them to the wage rate entails that the wage ratio of high-skilled vs low-skilled workers belonging to experience group $j$ is :

$$\frac{w_{Hjt}}{w_{Ljt}} = \left(\frac{A_{Ht}}{A_{Lt}}\right)^{\rho} \frac{\alpha_j}{\beta_j} \left(\frac{H_{jt}}{L_{jt}}\right)^{\eta-1} \left(\frac{H_t}{L_t}\right)^{\rho-\eta}. \tag{3.3}$$

or

$$log(\frac{w_{Hjt}}{w_{Ljt}}) = \beta_{0t} + \beta_1(log(\frac{H_{jt}}{L_{jt}}) - log(\frac{H_t}{L_t})) + \beta_2 log(\frac{H_t}{L_t}) + \delta_j \tag{3.4}$$

where $\beta_1$=$\eta-1$=$-1/\sigma_E$ and $\beta_2$=$\rho-1$ =$-1/\sigma$. They are assumed constant over time. $\delta_j$=$log(\frac{\alpha_j}{\beta_j})$ accounts for the experience-group relative efficiency parameters. $log(\frac{H_t}{L_t})$ stands for the relative aggregate labor supply and $log(\frac{H_{jt}}{L_{jt}})$, the experience-group relative labor supply. $\beta_{0t} = \rho log(\frac{A_{Ht}}{A_{Lt}})$ accounts for the relative technology term.

### 3.3.2 Estimated equations

For each year and experience group $j$, empirical estimations of the relative wage $log(\frac{w_{Hjt}}{w_{Ljt}})$, of the relative aggregate labor supply $log(\frac{H_t}{L_t})$ and the experience-group relative labor supply $log(\frac{H_{jt}}{L_{jt}})$ can be estimated. $\delta_j$ can be estimated by experience group fixed effects.

$\beta_{0t}$ is usually interpreted as a technology factor as it arises from a production function. In the empirical setting, it can be interpreted more generally as any factor impacting the demand for high-skilled workers relatively to low-skilled workers, hereafter demand shifters. There is evidence of a skill-biased demand shift if we find that the relative demand factor $\beta_{0t}$ is not constant over time and, in the case of a bias in favor of high-skilled labor, increases significantly. $\beta_{0t}$ is not observed. To be the most flexible, we could estimate it with year dummies but, in that case, the effect of the aggregate supply could not be identified and thus the year dummies could not be interpreted as the relative demand for high-skilled workers and that would prevent us from testing for the presence of a skill-biased demand shift. In fact, Card and Lemieux (2001) proposed a model in which time dummies absorb both supply and demand shifters, but only as a robustness check for the estimation of the partial elasticity of substitution between experience groups, which is the only identified parameter in that case. We run this robustness check but, as our main specification, we prefer to follow the literature and estimate the relative demand term with a polynomial time trend, choosing the order that fits best our data. Note that in the literature, when a skill-biased shift in demand is found in this setting, it is interpreted as a Skill-Bias Technical Change (SBTC) as it can be related to the technology parameter of the production function. We prefer to take a conservative position and refer to it as a skill-bias shift

in demand. Finally, as we suspect that if there has been a skill-biased shift in demand, it would have been induced by market factors similar to the US, we also want to control for institutional factors. So, in some specifications, the minimum wage is added as a control. Indeed the level of the minimum wage may affect the labor demand, and in particular the demand for low-skilled workers.

This leads to estimate

$$log(\frac{w_{Hjt}}{w_{Ljt}}) = \beta_0 + X_t\gamma + \beta_2 log(\frac{H_t}{L_t}) + \beta_1(log(\frac{H_{jt}}{L_{jt}}) - log(\frac{H_t}{L_t})) + \delta_j + \epsilon_{jt}. \tag{3.5}$$

where $X_t$ contains square or cubic time trends capturing the unobserved relative demand term and, in some cases, other institutional demand shifters such as the minimum wage level.

To test the sensitivity of the results to the specification, we also estimate the Katz and Murphy (1992) model which is similar, except that it does not allow for imperfect substitution between experience groups. It therefore only uses variations between years and not between experience groups, and leads to estimate

$$log(\frac{w_{Ht}}{w_{Lt}}) = \beta_0 + X_t\gamma + \beta_2 log(\frac{H_t}{L_t}) + \epsilon_t. \tag{3.6}$$

The primary parameters of interest are the time trends, which are expected to be significantly increasing. But we are also able to recover an estimation of the aggregate elasticity of substitution between high-skilled and low-skilled workers and of the partial elasticity of substitution between different experience groups within the same education group.

The main concern with this empirical strategy is the possible endogeneity of the labor supply by education level. The lengthening of studies could be a response to an increase in the demand for skilled labor. Moreover, in the short run, supply may also be affected by demand; for example, low-skilled workers may withdraw from the labor market if the demand for low-skilled workers is too low. Another limit is that the analysis is based on the choice of a functional form of the production function. The empirical strategy used here do not allow to tackle these issues but is still of interest as a descriptive tool of stylized facts and for a comparison of France with the US, for which it has been widely used in the literature.

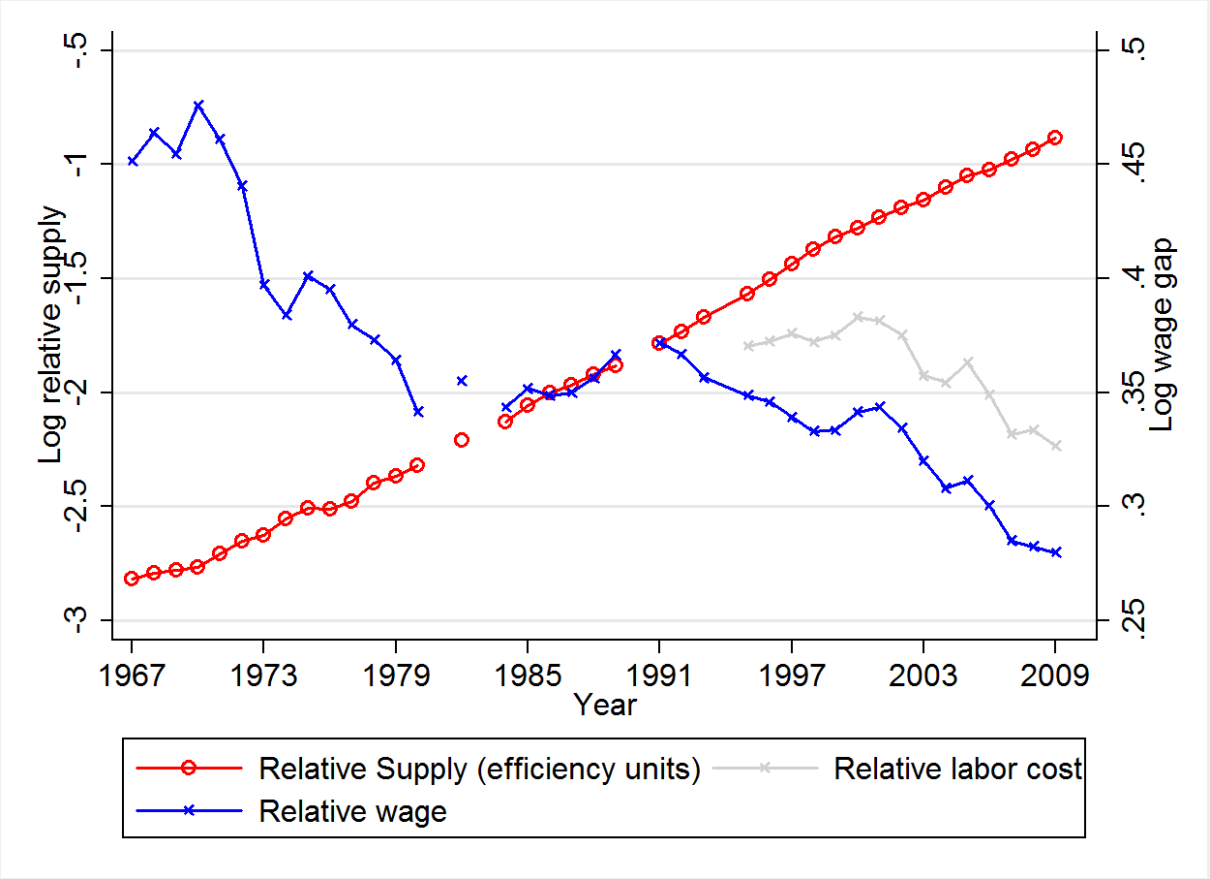
### 3.3.3 Relative supply and wage computations

To estimate our regressions, we need to compute for each year an estimation of the price (wage) and quantity (supply) of high-skilled workers and low-skilled workers of each experi-

ence group (0-10, 10-20, 20-30, 30-40). To estimate the price, a simple method would be to compute the mean or median of wages for each group, but, as we use ten-year-interval for experience and only two categories of education, composition effects might affect such estimations. Regarding quantity, we could use the number of days worked by each group but it would not take into account the fact that, for example, a day of work of a university worker may not have the same value in terms of input in the production function as a day of work of a some college worker. A similar reasoning holds within the low-skilled group and within 10-year-experience groups. To tackle these issues, we use the micro-data presented in the previous section to compute composition-adjusted estimations of the relative wage ($log(\frac{w_{Hjt}}{w_{Ljt}})$) and supply ($log(\frac{H_t}{L_t})$ and $log(\frac{H_{jt}}{L_{jt}})$), following Autor et al. (2008) (details in appendix 3.A). Figure 3.5 shows the trends of the resulting relative labor supply and wage. We find similar trends as the ones observed with more detailed education groups : an increase in the relative supply of high-skilled workers and a decrease in their relative wage. The relative supply measures are computed with male observations only. To check whether the strong feminization of the labor force changes results, we also consider relative supply measures computed on male and female observations. Results are the same and not presented for the sake of brevity.

### 3.3.4 Projections

Using the estimated parameters, we are also able to simulate the relative wage out to 2030 to assess the future evolutions of wage inequalities by skills. To run such an exercise, we need to make assumptions on the evolution of the relative labor demand ($\beta_{0t}$ in equation 3.4). We test several shapes : a constant (equal to to the level in 2009), a linear, a quadratic, and a cubic time trend. We also need projections out to 2030 of the aggregate and the experience-group supply measures. We use a simplified framework to obtain these projections. To focus on the effect of changes in education rather than changes in the sizes of cohorts, we consider that in the future the experience structure of the labor supply is fixed to the setting observed in 2009. So, for each future year, the number of workers, or of working days per one-year experience group, is fixed to the levels observed in 2009. However, their education structures change. The education structure of each one-year experience group simulated for a given year is the one observed (or simulated) the year before, for the group with one year less of experience. We make the implicit assumption that each year, each worker gains one year of experience, and we do not allow for inflows and outflows of the working population. The education structure of new entrants is the one observed in 2009.




Note: log relative supply: ratio of the college-equivalent to non-college equivalent labor supply index in efficiency units. Log relative wage and labor cost: log of a fix-weighted ratio of college to high school predicted LAD wages and labor costs to adjust for composition by experience and education changes over 1967-2009.

Figure 3.5: Changes in college/high school relative supply, relative wages and labor costs

## 3.4 Results

### 3.4.1 Hidden skill-biased demand shift between 1967 and 2009

In this part, we present the results of our estimations and assess if there has been a skill-biased shift in labor demand in France.

The results of equation 3.5 estimation are reported in columns (1)-(4) of Table 3.1. Columns (1)-(3) refer to the pooled OLS estimates with different specifications for the demand shifters $X_t$. We also estimate in column (4) the model proposed by Card and Lemieux (2001), in which time dummies absorb both supply and demand shifters. Finally, we estimate the canonical Katz and Murphy (1992) model (equation 3.6), in which experience groups are assumed to be perfect substitutes. Results are reported in columns (5)-(6). We report the partial $R^2$ of the different covariates to study their explanatory power in explaining the relative wage gap.

Examining time trends, we find evidence in favor of a skill-biased demand shift : in Table 3.1, we report the $p$-values of $F$-tests for a null time trend[16] and this nullity can be rejected at $10\%$. To give an idea of the magnitude of the skill-biased demand shift involved, but keeping in mind the precautions required by potential imprecision, we compare the estimated French levels of the time trend to those found in the U.S. by Autor et al. (2008).[17] Depending on the specifications used in Table 3.1, the increase in the relative log wage gap due to the time trend ranges from .51 to .70 after 40 years, vs .94 for the U.S.[18] That represents between 55% and 80% of what is found for the U.S.

Low-skilled workers' wages are on average closer to the minimum wage than high-skilled workers' wages. The effect of the strong increase in the minimum wage that occurred over the period may therefore have been greater on low-skilled workers, especially through spill-over effects whose intensity decreases over the wage distribution.[19] The minimum wage is thus included as a potential demand shifter, in columns (2) and (3).[20] Partial $R^2$s of the minimum

[16] $F$-tests do not account for the fact that relative wages are predicted.

[17] The time variable used in the analysis is centered in 1963 to allow direct comparisons with Autor et al. (2008).

[18] Using estimates of Katz and Murphy (1992) model, the increase in the relative log wage gap due to the time trend is smaller: between .17 to .36.

[19] The French minimum wage is set in blanket fashion and covers all workers, with no regional or sectoral differences. Since 1970, its level is increased by a percentage that cannot by law be less than one-half of the growth in the real hourly earnings of manual workers (skilled and unskilled). Its growth is given by a fixed linear combination of the blue collar hourly wage growth ("salaire horaire de base ouvrier"), the changes in inflation, and certain discretionary one-shot increases, called "coups de pouce" or *boosts*, which the government can add to the automatic re-evaluation. The minimum wage also increased from the late 1990s to the mid-2000s following the implementation of the 35-hour workweek reduction, (Law Aubry I and II, and Law Fillon); see Figure 3.14 in the Appendix.

[20] In column (6) for the Katz and Murphy (1992) model.

Table 3.1: Estimates for the high-skilled/low-skilled relative wage, 1967-2009

| | with imperfect substitutability between experience groups | | | | Katz-Murphy model | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| *Demand side* | | | | | | |
| Time | -0.000 | 0.021* | 0.010 | | -0.016*** | -0.019* |
| | (0.006) | (0.011) | (0.017) | | (0.003) | (0.009) |
| Time$^2/100$ | 0.088*** | -0.011** | 0.050 | | 0.121*** | 0.134*** |
| | (0.033) | (0.005) | (0.069) | | (0.018) | (0.038) |
| Time$^3/1000$ | -0.011*** | | -0.007 | | -0.015*** | -0.016*** |
| | (0.004) | | (0.008) | | (0.002) | (0.004) |
| Minimum wage | | -0.203*** | -0.091 | | | 0.032 |
| | | (0.077) | (0.148) | | | (0.081) |
| *Supply side* | | | | | | |
| Rel. Aggreg. supply | -0.475** | -0.321 | -0.444* | | -0.342** | -0.352** |
| | (0.238) | (0.201) | (0.244) | | (0.129) | (0.133) |
| Rel. exp. group supply | -0.192*** | -0.193*** | -0.192*** | -0.194*** | | |
| minus rel. aggreg. supply | (0.018) | (0.018) | (0.018) | (0.020) | | |
| $\sigma$ | 2.107 | 3.112 | 2.251 | | 2.927 | 2.838 |
| $\sigma_E$ | 5.205 | 5.178 | 5.196 | 5.159 | | |
| Constant | Y | Y | Y | Y | Y | Y |
| Experience group Dummies | Y | Y | Y | Y | N | N |
| Year Dummies | N | N | N | Y | N | N |
| Nb obs | 156 | 156 | 156 | 156 | 39 | 39 |
| $R^2$ | 0.58 | 0.58 | 0.58 | 0.61 | 0.94 | 0.94 |
| Pval F-test of no time trend | 0.053 | 0.058 | 0.090 | | 0.000 | 0.000 |
| Partial $R^2$ Ag. Sup | 0.026 | 0.017 | 0.022 | | | |
| Partial $R^2$ Exp. | 0.426 | 0.428 | 0.427 | | | |
| Partial $R^2$ Min Wage | | 0.046 | 0.003 | | | |

Source: EDP-DADS Data. 15- to 64-year-old full-time men working in the private sector.
Note: Standard errors in parentheses. Each column reports OLS regression results of the composition-adjusted high-skilled/low-skilled relative wage on indicated variables. Wages are computed weighting by the number of worked days. The log relative aggregate supply is the log of the ratio between the high-skilled labor supply measure and the low-skilled labor supply measure in efficiency units. Experience group dummies are included. Year dummies are included in columns (4). Time, in years, equals 1 in 1964. The year 1994 is not included in the computations because of poor quality data. See the Appendix for details. $F$ tests are not corrected for the fact that relative wages are predicted.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

wage is about 5%, when quadratic time trends are used to capture demand shifters, and null with a cubic time trend. The explanatory power of the minimum wage is hence quite small compared to that of the experience-group relative supply (40%). Changes in the minimum wage seem less relevant to explaining the high-skilled versus low-skilled wage differential than changes in relative labor supply. So, even in the French context of a minimum wage set comparatively high, minimum wage does not exert substantial influence on the high-skilled/low-skilled relative wage gap, and even if it did, changes in minimum wage would negatively affect the wage gap, entailing an under-estimation of the skill-biased demand trends. In contrast, its rise explains the decrease of wage inequalities at the bottom half of the distribution well (Charnoz et al. (2013) and Verdugo et al. (2012)).

Then, we focus on the estimates of the aggregate elasticity of substitution between high-skilled and low-skilled workers, and of the partial elasticity of substitution between experience groups within an education group, that we use for our projections. As expected in a supply/demand model, we observe negative effects of the aggregate supply on the relative wage gap, and of the relative supply in one's own experience group. Point estimates for the aggregate elasticity of substitution between high-skilled and low-skilled labors, $\sigma$, range from 2.1 to 3.6 (with large standard deviations), which is not so far from what is usually found in the U.S. or the U.K. – between 1.6 and 3.[21] Dustmann et al. (2009) find for Germany an elasticity of substitution between medium-skilled and low-skilled workers of around 4. In the Katz and Murphy (1992) version of the model, our estimates for $\sigma$ are somewhat larger, around 4.

In contrast to the aggregate elasticity, the partial elasticity of substitution between the experience groups is always precisely estimated. Depending on the specification used, the estimates range between 4.6 and 5.2, which is close, but again slightly higher than what is found for the U.S. Acemoglu and Autor (2011) report an elasticity of substitution between potential experience groups of 3.7 when they use both men and women. Card and Lemieux (2001) find elasticities of substitution between age groups of around 5 when they focus on men only. Our estimate for the partial elasticity of substitution across experience groups is similar (5.2) when we consider the Card and Lemieux (2001) model, in which time dummies account for both aggregate supply and demand shifters. We differ here from the results of Verdugo (2014), who estimates this model on the French Labor Force Survey data, 1990-2008. He finds much higher estimates of the partial elasticity of substitution between experience groups: between 8 and 12.5.

In the next section, we use these estimated parameters to compute some projections of wage inequalities by skills in the next twenty years.

[21] See Autor et al. (2008), Acemoglu and Autor (2011), Card and Lemieux (2001).

### 3.4.2 Wage inequality projection exercise

We find evidence a skill-biased demand shift but, in France, contrary to the U.S., the additional supply of high-skilled labor was not over-compensated by this increase in demand for this type of labor. In Tinbergen's context of a race between education and technology (Tinbergen, 1974, 1975), for France, education leads the race. Yet the decrease in the relative wage would have been much more pronounced if the demand for high-skilled labor had not increased.

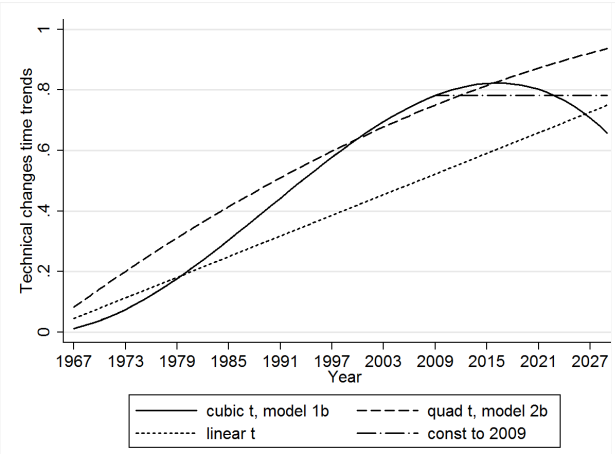
As documented above, since the beginning of the 2000s, the educational structure of new labor market entrants has somewhat stabilized. Might this lead to a turning point for wage inequality trends, as in the U.S. in the 1980s, when wage inequality started to grow as the supply of high-skilled labor slowed down? We propose a simple simulation exercise in order to give a first answer.

Panel (a) of Figure 3.6 presents the different evolutions of the relative labor demand we assume for our projections. Results of our projections of the wage of high-skilled workers relatively to low-skilled workers out to 2030 are reported for 3 experience groups in panels (b), (c) and (d). For workers with less than 10 years of experience, if the time trend effect on the relative demand persists, the relative wage of high-skilled workers will sharply increase from 2010 to 2020. The magnitude of this increase depends on the form of the time trends (constant, linear, quadratic or cubic) but all specifications (except the constant one) lead to this sharp increase in relative wages up to 2020. What will happen after 2020 depends on the form assumed for the time trend: the increase will continue if the relative demand follows a linear or quadratic rate or decrease if the relative demand decreases (cubic trend). Similar evolutions of the relative wage are found for the group of workers with 10 to 19 years of experience, but a decade later.

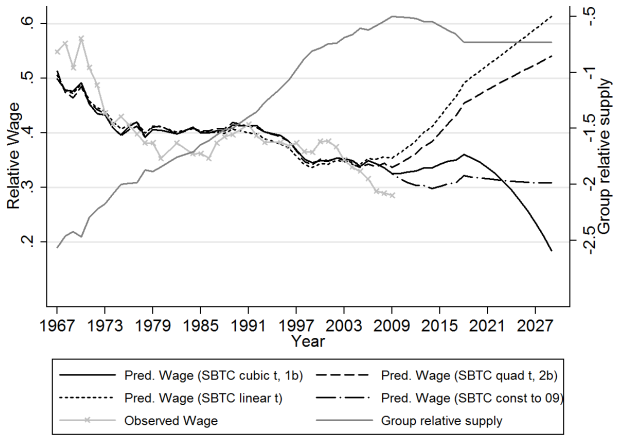
These simple simulations thus show that a rise in wage inequalities by skills similar to the US may occur in France if the demand for high-skilled workers relatively to low-skilled workers keeps increasing. To be able to assess whether this is plausible, one needs to assess the causes of the skill-biased shift in the US and in France. For instance, if this is due to ICT dissemination, and if France has not yet reached the US level, it is reasonable to assume that the skill-biased shift in labor demand is not yet over in France. Finding evidence on the determinants of the French skill-biased shift in demand is the purpose of the chapter 5.

Figure 3.6: Simulations of relative wages

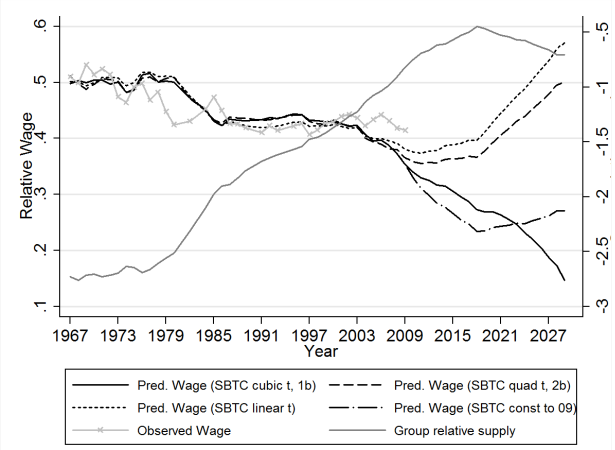
(a) Simulated time trends



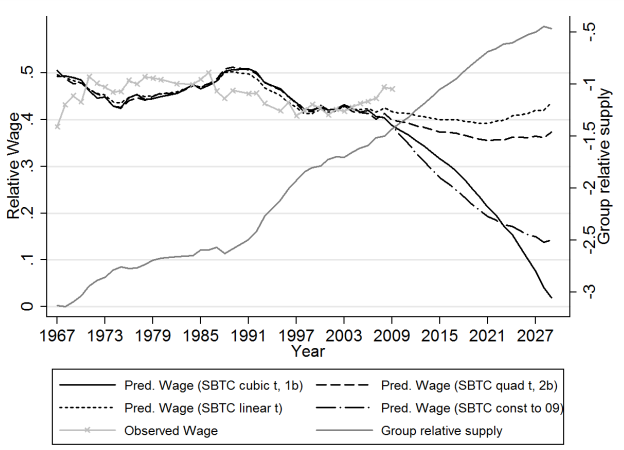

(b) Experience 0-9 years




(c) Experience 10-19 years




(d) Experience 20-29 years




Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector.

Note: For years $\geq$ 2010, supply measures are simulated. Supply measures are computed in worker efficiency units in worked days. Observed and predicted wages are reported up to 2009. Relative wages are predicted from Card-Lemieux model regressions as presented in Table 3.2 with future demand shifters (minimum wage) equal to the observed level in 2009, with cubic and quadratic time trends. We also consider the case when the future time trend is constantly equal to the 2009 level and the case of a linear trend. Subfigure (a) reports the corresponding time trends. See the Appendix for details.

## 3.5 Robustness checks

In this section, we conduct complementary analyses to check the robustness of our results. The latter may be subject to certain caveats. First, unemployment changes may affect the two skill groups differently, leading to unexpected changes in wage and supply measures. Second, up to this point we have considered net wages, for the reason that total labor costs, $i.e.$ total wages paid by the firm, which are more relevant measures, are not available during the whole period. This section examines robustness of our results to these concerns.

### 3.5.1 Selection into employment

The relative wage and the relative labor supply may be mis-estimated if unemployment affects high-skilled and low-skilled workers differently, and if these differences in the employment selection processes change over time and/or space. In what follows, we run several exercises, all of which lead us to think that variations of selection into employment do not affect our evidence of a skill-biased shift in demand.

First, we compare the results of Table 3.1 for which the relative wages and supply measures are weighted by job duration, and the same measures, with one annual wage observation per worker only, and without weighting by the job spell duration (columns (1)-(4) in Table 3.2). The wage in that case refers, for workers who occupied several jobs sequentially during the year, to the average daily wage over these different job spells. So workers who did not work year round – potentially due to spells of unemployment – bear the same weight as those who worked year round. We only miss individuals fully and continuously unemployed during more than one calendar year, a very small group.[22] The time trend estimates differ slightly but the magnitudes involved are quite similar.

Further, we compute our relative wage and supply measure on a modified dataset that we construct exploiting the panel structure of our data. We add to the initial micro data an annual observation for the individuals missing for a particular year, but observed the year before and the year after. We impute for this year a wage for each of them, equal to the average of their wages the year after and the year before. We then compute new measures of relative wage and supply and new estimations of our supply and demand equations (columns (1b)-(4b) in Table

[22]We also miss the self-employed and public servants. We have data on the public sector from 1988, a time period too short for us to run our estimations. However, inequalities and wage trends are very similar when the public sector is included. Moreover Verdugo (2014) finds similar trends on the sub-period 1990-2008 using the French Labor Force Surveys that provide information on both private and public sector wage earners.

3.2). The estimates for the time trend (and for the elasticities of substitution) are very similar to those of our main specification.

Table 3.2: Estimates for the high-skilled/low-skilled relative wage with imperfect substitutability between experience groups, 1967-2009, robustness check

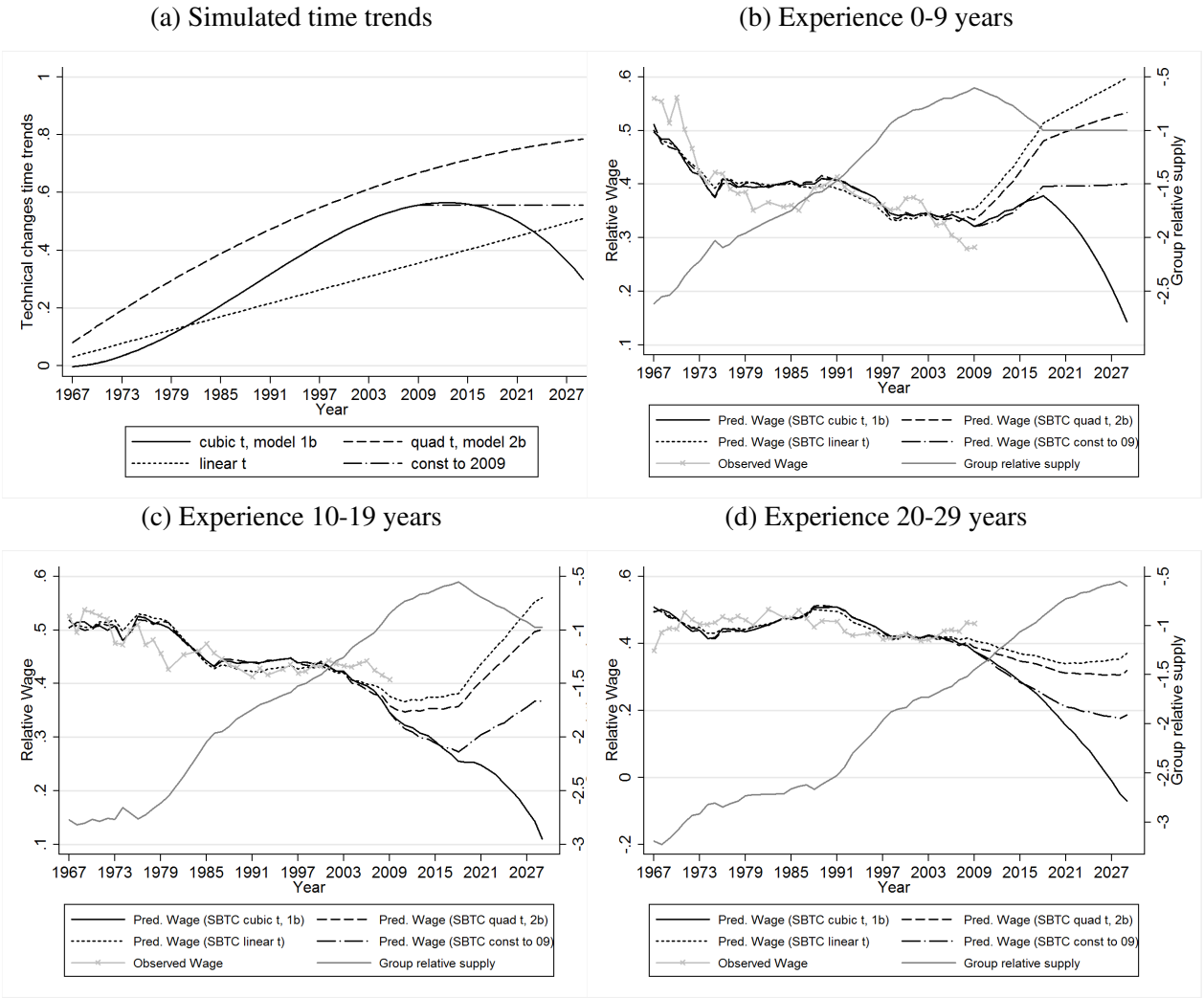
| | With supply measures in worker units | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (equal weight per worker) | | | | (equal weight per worker and one-year missing imputed) | | | |
| | (1) | (2) | (3) | (4) | (1b) | (2b) | (3b) | (4b) |
| *Demand side* | | | | | | | | |
| Time | -0.004 | 0.021** | 0.009 | | -0.003 | 0.019** | 0.003 | |
| | (0.006) | (0.010) | (0.018) | | (0.005) | (0.009) | (0.017) | |
| $\text{Time}^2/100$ | 0.086*** | -0.013** | 0.038 | | 0.082*** | -0.012** | 0.057 | |
| | (0.030) | (0.005) | (0.068) | | (0.027) | (0.005) | (0.065) | |
| $\text{Time}^3/1000$ | -0.011*** | | -0.006 | | -0.010*** | | -0.008 | |
| | (0.004) | | (0.008) | | (0.003) | | (0.007) | |
| Minimum wage | | -0.222*** | -0.121 | | | -0.202*** | -0.062 | |
| | | (0.076) | (0.153) | | | (0.068) | (0.148) | |
| *Supply side* | | | | | | | | |
| Rel. aggreg. supply | -0.372** | -0.276* | -0.346* | | -0.376** | -0.270* | -0.360** | -0.221*** |
| | (0.183) | (0.161) | (0.186) | | (0.169) | (0.151) | (0.173) | (0.021) |
| Rel. exp. group supply | -0.215*** | -0.216*** | -0.216*** | -0.217*** | -0.221*** | -0.222*** | -0.221*** | 0.536*** |
| minus rel. aggreg. supply | (0.019) | (0.019) | (0.020) | (0.021) | (0.019) | (0.019) | (0.019) | (0.030) |
| $\sigma$ | 2.688 | 3.624 | 2.886 | | 2.662 | 3.710 | 2.776 | |
| $\sigma_E$ | 4.644 | 4.623 | 4.633 | 4.604 | 4.520 | 4.504 | 4.516 | 4.515 |
| Constant | Y | Y | Y | Y | Y | Y | Y | Y |
| Experience group Dummies | Y | Y | Y | Y | Y | Y | Y | Y |
| Year Dummies | N | N | N | Y | N | N | N | Y |
| Nb obs | 156 | 156 | 156 | 156 | 156 | 156 | 156 | 156 |
| $R^2$ | 0.61 | 0.61 | 0.61 | 0.65 | 0.64 | 0.64 | 0.64 | 0.67 |
| Pval F-test of no time trend | 0.033 | 0.028 | 0.053 | | 0.022 | 0.028 | 0.041 | |
| Partial $R^2$ Ag. Sup | 0.027 | 0.020 | 0.023 | | 0.033 | 0.021 | 0.029 | |
| Partial $R^2$ Exp. | 0.454 | 0.456 | 0.456 | | 0.483 | 0.483 | 0.484 | |
| Partial $R^2$ Min Wage | | 0.055 | 0.004 | | | 0.056 | 0.001 | |

Source: EDP-DADS Data. 15- to 64-year-old full-time men working in the private sector.
Note: Standard errors in parentheses. Each column reports OLS regression results of the composition-adjusted high-skilled/low-skilled relative wage on indicated variables. Wages are computed weighting by the number of worked days (columns 1-4) or weighting each worker who worked at least once full time by one (columns 1b-4b). The log relative aggregate supply is the log of the ratio between the high-skilled labor supply measure and the low-skilled labor supply measure in efficiency units, in days (columns 1-4) and worker units (columns 1b-4b). Experience group dummies are included. Year dummies are included in columns (4) and (4b). Time, in years, equals 1 in 1964. The year 1994 is not included in the computations because of poor quality data. See the Appendix for details. $F$ tests are not corrected for the fact that relative wages are predicted.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

We also compute our projections weighting each worker by one instead of worked days in our relative wage and supply measures (figure 3.7). Results are similar. For the 10-19 years of experience group, the relative wage of high-skilled workers increases sharply up to 2020. The main difference is that it increases even when we assume a constant trend for the relative labor

demand. For the other groups of experience, results are similar to those found with our main specification.

Figure 3.7: Simulations of relative wages, robustness check




Source: DADS-EDP data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector.

Note: For years $\geq$ 2010, supply measures are simulated. Supply measures are computed in worker efficiency units. Observed and predicted wages are reported up to 2009. Relative wages are predicted from Card-Lemieux model regressions as presented in Table 3.2, with future demand shifters (minimum wage) equal to the observed level in 2009, with cubic and quadratic time trends. We also consider the case when the future time trend is constantly equal to the 2009 level and the case of a linear trend. Subfigure (a) reports the corresponding time trends. See the Appendix for details.

### 3.5.2 Total labor cost and net wages

Net wages differ from total labor cost by the payroll tax amount, paid either by the employer or the employee.[23] The payroll tax legislation depends partly on the remuneration level, and the firm size. Changes in payroll tax legislation may entail that total labor cost and net wage trends differ slightly, and as total labor cost is more relevant in the context of a production function setting, this could affect our estimates of a skill-biased demand shift.

We have individual information on the total labor cost paid by firms since 1995 only.[24] This does not provide enough time variation to conduct an analysis similar to the one conducted with net wages. We propose to control for changes in payroll taxation between 1967 and 2009 by including the median total labor cost to median net wage ratio in our estimations.

We first describe shortly the evolution of this ratio in relation with the evolution of the French legislation. Payroll taxes increased continuously from the mid-1970s to the end of the 1990s, even during the slow growth of the 1980s. First the employee-paid contributions increased, then the employer-paid ones did (INSEE (2009)). Consequently, the net wage to labor cost ratio at the median decreased from 1975 to the mid-1990s, and has stabilized since then (figure 3.15 in appendix).[25] Since 1993, several payroll tax subsidies for low wages have been paid to firms to protect low-qualified employment. They were largely extended between 1995 and 1996. In July 1993, these payroll-tax subsidies represented around 5% of the gross wage at the minimum wage, and 18% in October 1996. They concerned wages up to 1.33 minimum wage, $i.e.$ almost one third of the workers in the private sector, but the level of the subsidies was degressive with the wage level. Ultimately, from the beginning of the 1990s until 1996, the employer-paid contributions at the minimum wage decreased by 18 percentage points, from 40% to 22% (Crépon and Desplatz (2001) and Kramarz and Philippon (2001)). Since 1997, and parallel to the implementation of the reduction of the workweek to 35h, payroll tax subsidies have in part been extended to higher wages, up to 1.6 $\times$ the minimum wage, again in a degressive fashion. These changes lead to an increase in the net minimum wage to labor cost ratio since the mid-1990s but they do not affect the ratio at the median.

Table 3.3 presents the results of our robustness check that lead us to believe that, due to

[23] Including two taxes, the "contribution sociale généralisée", (CSG) introduced in 1990 and the "contribution pour le remboursement de la dette sociale" (CRDS), introduced in 1996.

[24] The total labor cost, computed in 2009 euros, is constructed by adding to the wage variable the total amount of the social contributions - whether paid by the firm or the employee. These social contributions are computed *a posteriori* by applying the applicable legislation rules, which depend on the year, the wage level, the number of employees in the firm, etc. The programs used to compute the labor cost at an individual level were constructed by the INSEE Division "marchés et entreprise", see Cottet, Quantin, and Régnier (2012)

[25] The daily labor costs are computed using the average number of hours worked per day. These two series are borrowed from Nouveau and Ourliac (2012a) and Nouveau and Ourliac (2012b).

Table 3.3: Estimates for the high-skilled/low-skilled relative wage with imperfect substitutability between experience groups, 1967-2009 : controlling for changes in payroll taxation

| | With supply measures in days (weighted by job duration) | | | With supply measures in worker units (equal weight per worker) | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (1b) | (2b) | (3b) |
| *Demand side* | | | | | | |
| Time | 0.001 | 0.025* | 0.013 | -0.001 | 0.031** | 0.016 |
| | (0.007) | (0.013) | (0.018) | (0.006) | (0.013) | (0.018) |
| Time$^2/100$ | 0.099*** | -0.015* | 0.056 | 0.118*** | -0.022** | 0.060 |
| | (0.037) | (0.009) | (0.069) | (0.038) | (0.010) | (0.070) |
| Time$^3/1000$ | -0.013*** | | -0.008 | -0.016*** | | -0.010 |
| | (0.005) | | (0.008) | (0.005) | | (0.008) |
| Minimum wage | | -0.233** | -0.111 | | -0.294*** | -0.152 |
| | | (0.092) | (0.150) | | (0.099) | (0.154) |
| Median labor cost | -0.144 | -0.123 | -0.169 | -0.317 | -0.254 | -0.350 |
| to net wage ratio | (0.210) | (0.209) | (0.213) | (0.237) | (0.226) | (0.239) |
| *Supply side* | | | | | | |
| Rel. aggreg. supply | -0.510** | -0.330 | -0.479* | -0.489** | -0.330* | -0.469** |
| | (0.244) | (0.201) | (0.248) | (0.202) | (0.168) | (0.203) |
| Rel. exp. group supply | -0.191*** | -0.193*** | -0.192*** | -0.214*** | -0.216*** | -0.215*** |
| minus rel. aggreg. supply | (0.018) | (0.018) | (0.019) | (0.019) | (0.019) | (0.019) |
| $\sigma$ | 1.962 | 3.032 | 2.086 | 2.044 | 3.029 | 2.131 |
| $\sigma_E$ | 5.227 | 5.192 | 5.220 | 4.663 | 4.631 | 4.650 |
| Constant | Y | Y | Y | Y | Y | Y |
| Experience group Dummies | Y | Y | Y | Y | Y | Y |
| Observations | 156 | 156 | 156 | 156 | 156 | 156 |
| $R^2$ | 0.58 | 0.58 | 0.58 | 0.61 | 0.61 | 0.62 |
| pval F test for no trends | 0.055 | 0.138 | 0.171 | 0.020 | 0.055 | 0.065 |

Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector.
Note: Standard errors in parentheses. Each column reports OLS regression results of the composition-adjusted high-skilled/low-skilled relative wage on indicated variables. Wages are computed weighting by the number of worked days (columns 1-3) and weighting each worker who worked at least once full time by one (columns 1b-3b). The log relative aggregate supply is the log of the ratio between the high-skilled labor supply measure and the low-skilled labor supply measure in efficiency units, in days (columns 1-3) and worker units (columns 1b-3b). Experience group dummies are included. The log of the median labor cost to net wage ratio is included in the regressions to control for changes in payroll taxation. Time, in years, equals 1 in 1964. The year 1994 is not included in the computations because of poor quality data. See the Appendix for details. $F$ tests are not corrected for the fact that relative wages are predicted.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

changes in payroll tax legislation, the skill-biased demand shift effect on the relative wage found previously may in fact underestimate the true effect. The coefficient relative to the median total labor cost to median net wage ratio is imprecisely estimated but we obtain time trend estimates that predict, after the mid-1990s, a stronger increase in the relative wage than what we found previously. The increase in the relative wage due to changes in demand after 40 years is now very similar to the U.S., between 82% and 102% of the effect found by Autor et al. (2008).

The evidence of a skill-biased shift in labor demand in France between 1967 and 2009 seems thus robust to both selection into employment and changes in payroll taxation.

## 3.6 Extension to local labor markets

France has experienced a skill-biased demand shift over the last 40 years, but the strong increase in educational attainment has masked this trend up to now. Evidence of skill-biased demand shift has been found for many other developed countries and its causes are much debated. One of the most cited cause of those shifts is technical change, which is thought to be skill-biased : information and communication technology (ICT) is hypothesized to have been complement to high-skilled jobs but substitute to some unskilled jobs. The rise of ICT would therefore entail a deformation of the relative demand. Globalization and offshoring could also explain the transformation of the relative demand for skilled workers, for it would lead to a decrease of demand for unskilled jobs in rich countries with high labor costs. Other explanations could be social or demographic trends such as the increasing labor force participation of women or the ageing of the population that may have increased the demand for workers in child and elderly care. Similarly, if more educated workers have different taste in consumption, the rise of the population education level may have increased demand for unskilled jobs in some specific industry such as tourism or entertainment for instance.

Recent papers (Autor and Dorn (2013), Autor et al. (2013)) used differences between local labor markets to test for some of these potential explanations for the US. Moreover Moretti (2013) and Lindley and Machin (2014) have documented that, in the US, inequalities in labor supply and wages by skills tend to diverge across local labor markets : they have increased more in some major cities. Moretti (2013) relates this feature to the fact that the demand for high-skilled workers relatively to low-skilled workers increased more in these large cities. In other words, the skill-biased shift in labor demand has a spatial dimension. Potential candidates to explain these differences between local labor markets are technology, trade and agglomeration economies. These are mostly market factors and not institutional ones, and common to devel-

oped economies. We thus suspect that similar trends on the spatial dynamics of labor demand occurred in France too. As there is almost no evidence on the trends of labor supply, demand and wages by skills at the level of local labor markets in France, we document them in this section and, in the next chapter, we propose a test of the ICT hypothesis using differences between French local labor markets.

### 3.6.1 Literature

Lindley and Machin (2014) showed that in the US, the rise in wage inequalities between 1980 and 2010 by skills has a spatial component. They first documented that wage inequalities between skills increased more in some labor markets (defined as states or Metropolitan Statistical Areas, MSA) and that the supply of high-skilled workers increased more in the same labor markets.[26] Drawing on the canonical Katz and Murphy (1992) relative supply and demand model and estimating it for states or MSA's, they then showed that there has been an increasing spatial inequality in the relative demand for high-skilled workers. Moretti (2013) pointed out that high-skilled workers usually do not live in the same places as low-skilled workers and that taking into account the cost of living might lead to different conclusions on "real wage inequalities" (or well-being inequalities) between high and low-skilled workers as local prices vary sharply across space. He indeed found that the rise in inequality in the last 30 years in the US is much lower when taking local prices into account. This naturally leads to the question of why high-skilled people concentrated in more expensive places. He showed that it was, at least partly, due to a spatial shift in the relative demand for high-skilled workers and not merely to the fact that high-skilled workers got more attracted by the amenities of the cities. Diamond (2015) showed that an endogenous increase in the amenities of high-skilled cities also occurred and reinforced the demand shift.

There is less evidence on the evolution of the spatial dimension of wage inequalities by skills in France. Combes et al. (2008), Combes et al. (2012) and Combes et al. (2015) analyzed the spatial distribution of wages and skills in France on average on the last 20 years but they did not provide results on time trends. These papers belongs to a literature which explain why wages are higher in some places (often the most dense areas). This literature estimates whether this is due to the fact that high-skilled workers tend to live in different places than low-skilled workers (sorting) or to the fact that workers are more productive in denser areas thanks to agglomeration economies (Duranton and Puga (2004)). For France, Combes et al. (2008) showed that the sorting of workers by skills explains the major part of spatial wage inequalities in France and

[26] See also Berry and Glaeser (2005).

Combes et al. (2012) showed that workers in denser areas are more skilled. However most recent papers of this literature (de la Roca and Puga (2012) and Combes et al. (2015) for an application on French data) showed that, due to learning by doing effects, workers are becoming more productive in denser areas and remains more productive even after moving out of these areas. There are therefore "dynamic agglomeration economies" and the distinction between skill sorting and agglomeration economies effects is more complex. The analysis presented here is complementary to this literature in the sense that it studies the wage inequality between high and low-skilled workers within local labor markets, rather than estimating how much of the wage inequality between local labor markets is due to skill composition effects.[27] And it also documents trends (between 1982 and 2011) rather than global results for a studied period.

### 3.6.2 Data and empirical strategy

In the US, Moretti (2013), Lindley and Machin (2014)) found a spatial divergence both in supply and wages of high-skilled workers relatively to low-skilled. As a comparison, we present here a similar analysis for France between 1982 and 2011.[28]

#### Data issues

We use mostly the same data set (the EDP-DADS panel, an administrative database of annual employer-employee wage bill information matched with some Census information) and measures of relative supply and wage as in the previous chapter. We also use the same sample of male private sector wage earners. In the data set, the location of work is available at a fine geographical level (municipality). As administrative units are not a relevant geographical level of observation for labor market issues, we use the "employment zones" level, a zoning similar to the commuting zones used by Autor and Dorn (2013) and specifically designed to study local labor markets. There are 304 French employment zones (2010 zoning) but, we aggregate some of the least populated of the same region to get enough observations to estimate our supply and wage measures. We end up with 86 zones[29] (see appendix 3.C for details on the aggregation method used). To measure the supply of workers by education level, we can also use the 1982 and 2011 Censuses. This allows us to get more observations, and also to test the robustness of our results by computing a supply measure on the whole labor force rather than on the private

[27] One link between these approaches would be to account for differences in agglomeration economies by skills. Baum-Snow et al. (2014) propose such an approach on US data.

[28] Results are focused on men to be consistent with the first part. In the literature, they are often presented on men and women. Results on men or women for France are not presented here but are very similar.

[29] Results are robust to various ways of aggregating employment zones.

sector wage earners, thus taking into account potential selection issues. For this reason, and since we need for the analysis to compute changes between two points in time, we use 1982 as the start year and 2011 as the end year for the spatial analysis run in this chapter.[30]

**Relative wage and supply measures.** As in the previous chapter, we use the log of the daily wage. Relative wages of high-skilled compared to low-skilled workers are also computed in a similar fashion than in the previous chapter (appendix 3.A for details) but for each local labor market separately. Relative supply is the share of high-skilled workers among male wage earners of the private sector, computed in 'efficiency units 'and worked days for each local labor market.[31] Using the Censuses, an alternative measure is computed in efficiency units with each individual in the labor force weighted as one, independently of the number of days he worked, and including unemployed individuals, self-employed and public employees. Supply measures computed on male and female are also used in robustness checks.

### Spatial relative supply of high-skilled workers

In this section, we investigate the relative distribution of high-skilled workers across French employment zones and its evolution between 1982 and 2011.

The map of Figure 3.8 shows the distribution of our measure in efficiency units of the share of male high-skilled workers in France.[32] The employment zones of Paris and Saclay (the largest Parisian university campus) have a particularly high supply of male workers with a college or university degree, close to 35%. Large urban labor markets such as the ones around Grenoble, Lyon or Toulouse also have a share close to 30%. Employment zones with the lowest shares are mostly agricultural areas.

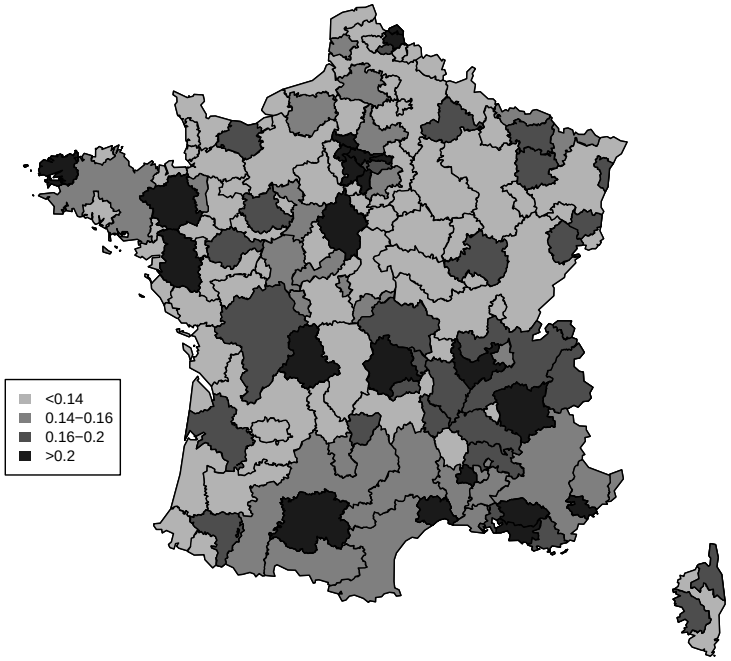
Figure 3.9 depicts the share of high-skilled among male workers by zone in 1982 and 2011 and reports the fit of a linear relationship between the two dates. The increase in the level of education of workers, that we have described in the previous section, occurs everywhere but with variable intensity across areas. There is a positive relationship between the level in 1982 and in 2011. The coefficient of the linear regression is significantly higher than 1, indicating a spatial divergence : the employment zones that had the highest share of high-skilled workers in 1982 experienced the largest rise in this share. Inequalities in high-skilled workers supply

[30]To our knowledge, there is no other source on wages by education level over a similar period of time available for France with a bigger sample.

[31]This measure is slightly different from the one used in the previous section because of the empirical strategy, see next section.

[32]This is computed for male and weighted by job duration in the private sector, but it is similar for male and female or when taking each individual of the labor force and weighting by one rather than by job duration.

Figure 3.8: Share of male high-skilled workers by employment zones in 2011

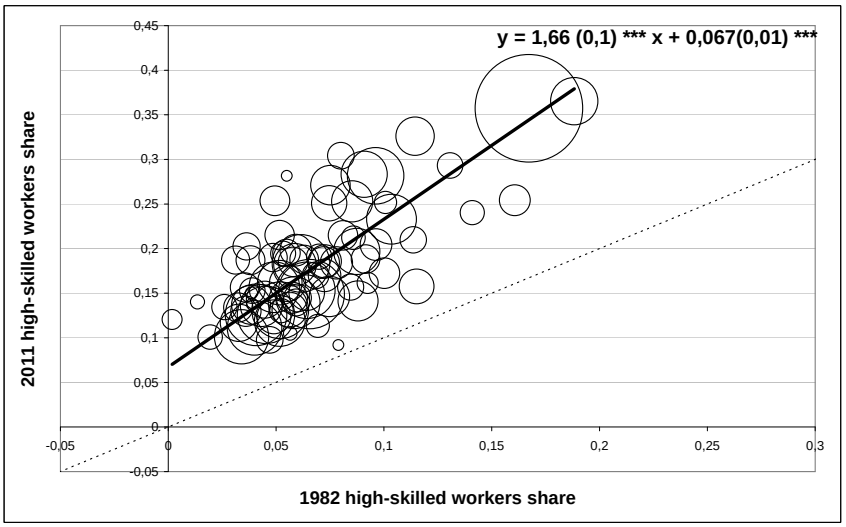



Source : EDP-DADS panel, metropolitan France, 15-65 year old male labor force.

Note : Share of male high-skilled workers in efficiency units. Within a region, some employment zones are grouped, see the Appendix for details.

between employment zones have thus increased. These trends are very similar to those observed in the US, where high-skilled workers have concentrated in some specific metropolitan areas (Moretti (2013), Lindley and Machin (2014) among others).

Figure 3.9: Share of high-skilled workers by employment zones in 2011 and 1982




Source : Insee, EDP-DADS, metropolitan France, 15-65 year old male wage earners working in the private sector.

Note: Standard errors in parentheses. Share of high-skilled workers in efficiency units and worked days. Estimations are weighted by employment zones population size. The size of the bubble is proportional to the employment zone population size. Within a region, some employment zones are grouped, see the Appendix for details.

* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

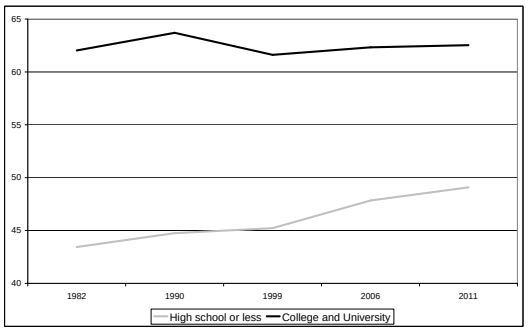
The spatial concentration of high-skilled workers can be due to an increase in their mobility toward these places or/and to an increase of the level of education of people from these places. To give some clues regarding these issues, we use the place of birth of workers[33] (Degorre (2015)) and compare it to their place of residence using French Censuses. We consider a worker has moved if he does not live in his department of birth. The mobility rate of high-skilled workers did not evolve much on the studied period, while that of the low-skilled workers has increased but remained lower than the one of the high-skilled workers (see figure 3.10 (a)). In order to further shed light on this issue, we regress the share of high-skilled workers by place of birth in 2011 on the one in 1982, to compare with the estimation by current place of work in Figure 3.9. This is done at the department level as it is the only available information. The coefficient is also significantly higher than 1 (figure 3.10 (b)) : the level of education has increased more where it was already high in 1982. These elements seem to indicate that the concentration of high-skilled workers is not due to a dramatic change in mobility patterns, but

[33]It is at the department level rather than at the employment zone level as only this information is available.

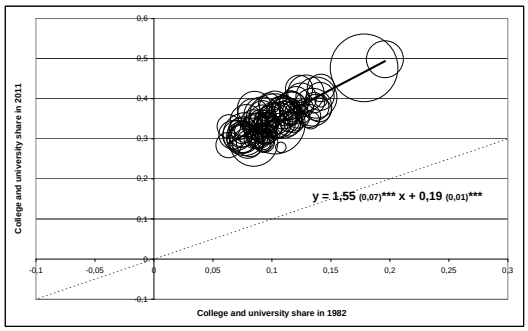
rather to the fact that people increased their level of education more in some places than others. This could due to differences in local education choices or policies.

Figure 3.10: Spatial mobility of workers

(a) Mobility rate by education level 1982-2011




(b) Share of high-skilled workers by department of birth in 1982 and 2011




Source : Insee, Censuses, metropolitan France, 15-65 year old labor force.

Note: Standard errors in parentheses. Estimations are weighted by department population size. The size of the bubble is proportional to the department population size. Mobility rate is defined as the share of workers not living in their department of birth.

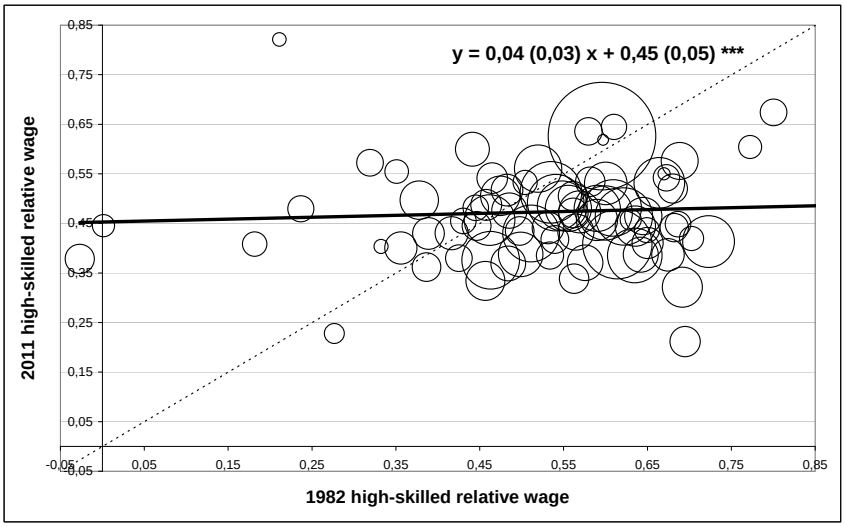
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

### Wage inequalities by skills across local labor markets

This section investigates how the differences in high-skilled relative wage between local labor markets have evolved during the period 1982-2011.

In 1982, the high-skilled relative wage was lower in large cities, mostly because the wage of low-skilled workers was higher there. To study the evolution of spatial patterns, we relate the 1982 relative wage by employment zones to the one in 2011 (figure 3.11). The dispersion of the relative wage is lower in 2011 than in 1982, so it got more homogeneous across space between 1982 and 2011. The slope is not significantly different from 0, which means that there is no link between the hierarchy of employment zones in terms of relative wage in 1982 and 2011. In other words, in France during the last 30 years, the relative wage of high-skilled workers has decreased less in large urban areas, where it was initially lower. There therefore has been a convergence between employment zones of the relative wage of high-skilled workers which is in sharp contrast with the United States where a divergence occurred (Lindley and Machin (2014), Moretti (2013)).

Figure 3.11: High-skilled/low-skilled relative wage in 2011 in function of 1982, by employment zone




Source : EDP-DADS panel, metropolitan France, private sector, 15-65 year old male wage earners in the private sector.

Note: Standard errors in parentheses. Estimations are weighted by employment zones population size. The log relative wage is the log of a fix-weighted ratio of high-skilled to low-skilled predicted LAD wages, adjusted for composition by experience and education changes. LAD wages are computed weighting observations by the job duration. Within a region, some employment zones are grouped, see the Appendix for details.

* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

To sum up, in France, as in the US, the high-skilled workers concentrated in large urban areas in the last 30 years. But, whereas a divergence of wage inequalities by skills between local labor markets occurred in the US, a convergence is observed in France. This can be related to the fact that the markets where the share of high-skilled and their relative wage were higher were the same in the US but not in France. To further explore and understand the similarities and differences in French and US local labor markets dynamics, we now turn to the exploration of the spatial differences in the demand for high-skilled workers relatively to low-skilled workers.

**Empirical strategy**

In line with Moretti (2013), we test whether the skill-biased shift in labor demand found in the previous chapter is homogeneous across local labor markets. The approach is similar to that of the previous chapter since it derives equations to be estimated from theory. However the equations are based on relationships determined at the equilibrium of the model, whereas the theoretical model was only partially solved in the previous strategy. Lindley and Machin (2014) used an approach more directly derived from the models we used at the national level. They estimated a Katz and Murphy (1992) model for each labor market, thus treating each market separately. This approach does not take into account the potential mobility of workers and differences in local prices and amenities between labor markets. Therefore, one major concern is the endogeneity of the local labor supply. To address this issue, Lindley and Machin (2014) proposed an instrumental variable strategy based on the place of birth of workers. We have seen in the previous section that the mobility pattern in France did not change much and that the concentration of high-skilled workers was probably more linked to local education choices. An instrument based on the place of birth would not be very relevant for France. This is why we prefer to use Moretti (2013) approach.

More precisely, Moretti (2013) uses the predictions of a theoretical model of supply and demand with two types of workers (more and less educated) and spatial equilibria on the labor and housing markets. This allows him to assess whether the spatial concentration of high-skilled workers is due to a demand shift. If it is due to a demand shift, the share of high-skilled workers has to increase in those areas where the skilled jobs are. If it is a supply shift, some areas become more attractive for some other reasons, such as amenities. The model predicts a relationship between changes in the share of high-skilled workers and changes in education premiums. The estimated equation is the following :

$$log^{2011}\left(\frac{w_{Hl}}{w_{Ll}}\right) - log^{1982}\left(\frac{w_{Hl}}{w_{Ll}}\right) = \alpha + \beta\left[\left(\frac{H_l}{H_l+L_l}\right)^{2011} - \left(\frac{H_l}{H_l+L_l}\right)^{1982}\right] + \epsilon_l. \quad (3.7)$$

$l$ being a local labor market, $log(\frac{w_{Hl}}{w_{Ll}})$ the relative wage of high-skilled compared to low-skilled for a local labor market $l$ (adjusted for skill composition, see appendix 3.A), $\frac{H_l}{H_l+L_l}$ the share of high-skilled workers (in efficiency units). Estimations are weighted by the 1982 population size of employment zones.

As stressed by Moretti (2013), it is not a causal relationship but an equilibrium relationship. If the concentration of high-skilled workers (as observed in the US and in France) is due to a demand shift, there should be a positive correlation between their changes ($\beta$ significantly positive) : because the relative demand of high-skilled workers increased more in some places, high-skilled workers concentrated there and their wage premium (or relative wage) increased (relatively to other places). If it is a supply shift, then no relation should be observed ($\beta$ not significant). High-skilled workers concentrated to some places expecting a higher utility through amenities but not through wages. Diamond (2015) proposed another approach, also based on a theoretical model, but, contrary to Moretti (2013), she did not use a reduced form but a structural econometric specification. In particular, in her empirical implementation, she used estimates of demand shocks based on the local industrial mix and data on local amenities. Her results are consistent with Moretti (2013).

For the US, Moretti (2013) shows that the relative wage of high-skilled workers increased significantly more in those places where they have concentrated more, evidence of a skill-biased spatial shift in demand. We test this relationship between high-skilled workers relative supply and wage changes across French local labor markets.

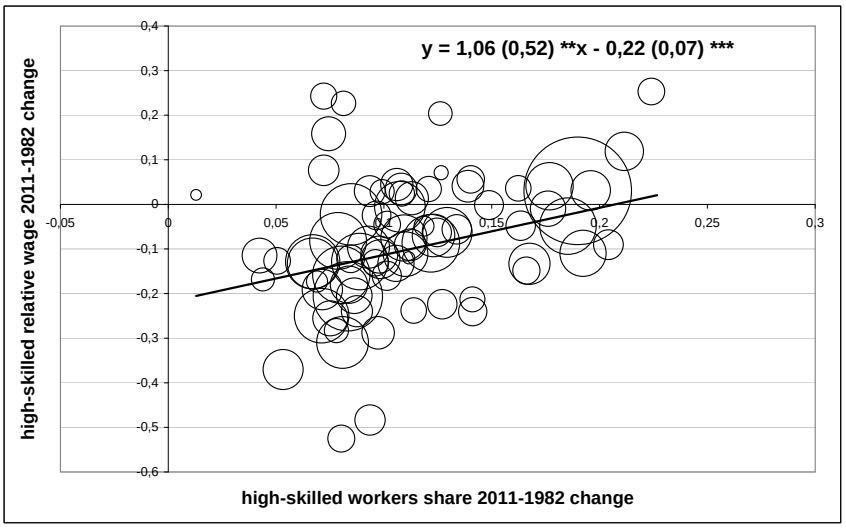
### 3.6.3 Results : skill-biased spatial shift in demand

So far, we have observed a spatial divergence in high-skilled workers relative supply, but a spatial convergence in their relative wage. Now, we investigate the spatial dynamics of high-skilled workers demand relative to low-skilled workers demand in France between 1982 and 2011 with Moretti (2013) approach.

Figure 3.12 relates the change in the share of high-skilled workers between 1982 and 2011 to the change in high-skilled/low-skilled relative wage (equation 3.7). We find a significant positive relationship, similar to what Moretti (2013) found for the US. The concentration of

high-skilled workers seems therefore, at least for some part, due to a spatial shift in their relative demand. An important difference between the US and France is that the concentration of supply and demand of high-skilled workers occurred in places where the relative wage was already higher in the US, in contrast to places where it was lower in France. Because of this difference in initial situations, a spatial divergence in high-skilled/low-skilled relative wages is observed in the US and a spatial convergence in France. But if trends remain the same in the future, this may lead to a spatial divergence of high-skilled/low-skilled relative wages in France too.

Figure 3.12: 2011-1982 change in high-skilled/low-skilled relative wage in function of the change in high-skilled workers share, by employment zone




Source : EDP-DADS panel, metropolitan France, private sector, 15-65 year old male wage earners

Note: Standard errors in parentheses. Estimations are weighted by employment zones population size. The relative supply is the share of high-skilled workers in efficiency units and worked days. The log relative wage is the log of a fix-weighted ratio of high-skilled to low-skilled predicted LAD wages to adjust for composition by experience and education changes. LAD wages are computed weighting by the number of worked days. Within a region, some employment zones are grouped. See the Appendix for details.

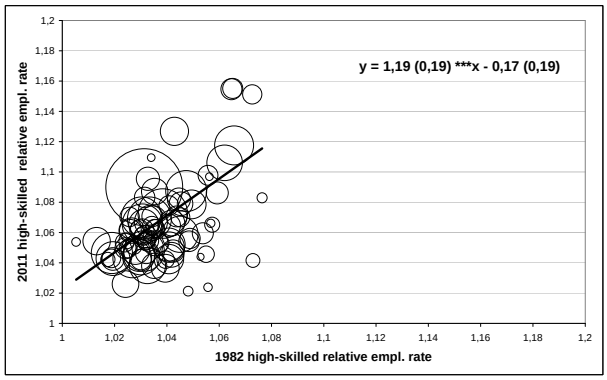
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

As the unemployment rate is quite high in France compared to the US, we suspect that supply and demand effects could also be visible through differences in employment. We therefore use the Censuses to compute composition-adjusted employment rate among the male labor force. Panel (a) of Figure 3.13 relates the level of the composition-adjusted employment rate of high-skilled workers relatively to low-skilled workers in 1982 and 2011 across local labor markets. As the coefficient is higher than 1 (although not statistically different than 1), it shows that, contrary to wages, there is no convergence of employment inequalities by skills between French local labor markets. We then test whether there is a positive relationship between the change in high-skilled/low-skilled relative employment rate and the change in the share of high-skilled

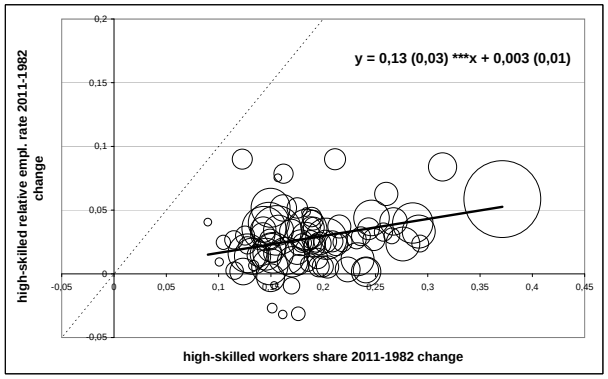
workers. We propose this as another test of a spatial divergence in the relative demand for high-skilled workers. If the demand for skills increased more in the markets where the relative supply increased, we expect the differences in employment by skill levels to have increased more in these markets. We indeed find a positive significant effect (panel (b) of Figure 3.13) , which reinforces evidence of a skill-biased spatial shift in demand.

Figure 3.13: High-skilled/low-skilled relative employment rate results by employment zone

(a) High-skilled/low-skilled relative employment rate in 2011 in function of 1982




(b) High-skilled/low-skilled relative employment rate 2011-1982 change in function of high-skilled workers share 2011-1982 change




Source : EDP-DADS panel, metropolitan France, 15-65 year old male.
Note: Standard errors in parentheses. Estimations are weighted by employment zones population size. The relative supply is the share of high-skilled workers in efficiency units and worked days. The relative unemployment rate is a fix-weighted ratio of high-skilled to low-skilled workers predicted OLS employment rates, adjusted for composition by experience and education changes. Within a region, some employment zones are grouped, see the Appendix for details.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

So, even if time and space dynamics of wage inequalities have been different from the US so far, we find evidence of similar dynamics of the demand for high-skilled workers in France. That may lead to more similar dynamics on wages in the future. In other words, France might experience an increase in wage inequalities by skills across employment zones, similar to the one the US have already been experiencing.

### Robustness checks

We test here whether results change when we use different measures of relative wages and labor supply. More precisely, since unemployment is higher for low-skilled workers and since the difference in unemployment rate between high and low-skilled workers might not be constant over time and space, this might biased our estimations of relative wage and supply dynamics.

Table 3.4 reports only the coefficient of interest $\beta$ of equation 3.7, which is the coefficient of the relationship between the changes in relative wage and supply, in each specification. Column (1) reports the result of our main specification (displayed in Figure 3.12). In column (3), we present estimations weighting wages by worker unit instead of job duration. For the supply measure, we also weight by worker unit and take advantage of the Censuses to compute a measure including self-employed, unemployed and public employees. We compute in column (5) alternative measures of relative wage and supply using a data set with imputed workers when only one year is missing as previously (see previous section for more details). And we also present estimations including women in the supply measure in column (2), (4) and (6). All specifications show a significant skill-biased spatial shift in demand.

Table 3.4: Test of skill-biased spatial shift in demand: robustness check

| | no imputed workers | | | | one-year missing imputed workers | |
|---|---|---|---|---|---|---|
| | weighted by job duration | | each worker has equal weight | | each worker has equal weight | |
| | supply : men | supply : all | supply : men | supply : all | supply : men | supply : all |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | Relative wage 2011-1982 change | | | | | |
| Relative supply 2011-1982 change | $1.057^{**}$ | $1.185^{**}$ | $0.998^{***}$ | $1.068^{***}$ | $0.859^{***}$ | $0.943^{***}$ |
| | ( 0.524 ) | ( 0.508 ) | ( 0.321 ) | ( 0.343 ) | ( 0.346 ) | ( 0.370 ) |
| Nb obs | 86 | 86 | 86 | 86 | 86 | 86 |

Source: EDP-DADS Data. 15- to 64-Year-Old male wage earners working in the Private Sector. 1982 and 2011 Censuses, 16-65-year-old labor force.
Note: Standard errors in parentheses. Estimations are weighted by employment zones population size. The log relative supply is the share of college equivalent workers among college and high-school equivalent workers, weighted in efficiency units (in columns (1) to (2) and worker units in columns (3) to (6). The log relative wage is the log of a fix-weighted ratio of college to high-school predicted LAD wages to adjust for composition by experience and education changes. LAD wages are computed weighting observations by the job duration in columns (1) to (2), and by one for each worker in columns (3) to (6). Within a region, some employment zones are grouped. See the Appendix for details.
* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

The stylized fact of a stronger increase in demand for high-skilled workers relatively to low-skilled workers in large urban areas is thus robust to various ways of measuring supply and wages.

# Conclusion

Over the last forty years at the national level, we have found evidence that, despite trends on wage inequalities by skills opposite to the US ones, evidence of an increase in the demand for high-skilled workers relatively to low-skilled workers similar to what has been documented

for the US can be found. This increase has been hidden by the increase in the education level in France that occurred later than in the US. If the lengthening of studies slows down and the relative demand for skilled labor keeps rising, wage inequalities by skills may increase in France as they did in the US.

Next, we have shown that in France high-skilled workers concentrated in large cities over the last thirty years, and that the demand for high-skilled workers relatively to low-skilled workers increased there too. Spatial dynamics of the relative labor demand and supply by skills are therefore also similar to the US. But, these dynamics have not led to the same spatial dynamics in wage inequalities by skills because of different initial situations in wage inequalities by skills between local labor markets. In the US, wage inequalities by skills were higher at the beginning of the studied period in the markets where the share of high-skilled workers was initially higher. In France, wage inequalities by skills were higher where the share was lower. Similar spatial dynamics of labor supply and demand by skills led thus to a spatial divergence in wage inequalities by skills in the US but a spatial convergence in France. But, if these spatial trends continue, a spatial divergence may occur in France.

To determine what are the likely future trends of the relative demand for skilled labor, it is necessary to investigate its determinants. For instance, if the observed trend is due to technical change and computerization was slower in France, we could expect that the demand for skilled labor will keep increasing as computer adoption is completed. In the next chapter, we therefore test whether ICT dissemination is a driver of the demand for skilled labor.

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# Appendices

## 3.A Technical appendix : relative wage and supply computations

**Relative wage.** For each year, we need to compute an estimation of the wage (price) of high-skilled workers and low-skilled workers for each experience group controlling for composition effects. We use a Mincer-type model (Mincer, 1974) in which log daily wages are related to education and experience. Education-group dummies are interacted with experience, experience$^2$, and experience$^3$ to allow heterogeneous effects of experience:

$$Median(y_i|dip_i, exp_i) = \sum_{k=1}^{7}(\beta_{k\theta} + \gamma_{1k\theta}exp_i + \gamma_{2k\theta}exp_i^2 + \gamma_{3k\theta}exp_i^3)\mathbf{1}_{dip_i=k},\ i = 1, \ldots, N, \tag{3.8}$$

where $Median(y|dip, exp)$ denotes the median of the conditional log wage distribution, $exp_i$ denotes the experience as a wage earner in the private sector, and $\mathbf{1}_{dip_i=k}$ is a dummy variable equalling 1 if individual $i$ holds the degree $k$, and 0 otherwise. We use 7 levels of education which is the most detailed level of education available. We estimate this model year by year. It is equivalent to a Least Absolute Deviations (LAD) estimation (or quantile regression at the median, see Koenker and Bassett (1978) , Buchinsky (1994), Fortin and Lemieux (1998), Gosling et al. (2000), Autor et al. (2005)).[34]

For each experience group $j$ (0-10, 10-20, 20-30, 30-40), we use an estimation of the log wage at the middle at the interval to control for composition effects by experience. So, for the 7 education levels, we recover median log wages with 5, 15, 25 and 35 years of real experience. For each level of experience $j$, the composition-adjusted log wages for high-skilled workers ($log(w_{Hjt})$) is the average of the ones for university and the ones for some college workers, weighted according to their average share over 1967-2009 of worked days in the total of the high-skilled group. Similarly, the composition-adjusted wages for low-skilled workers ($log(w_{Ljt})$) is the average of the ones for high-school, high vocational, low vocational, junior high-school and no degree, weighted according to their average share over 1967-2009 of worked days in the total of the low-skilled group. Using fixed weights computed on the whole period allows to control for composition effects by education level within the two broader education

[34]It is preferred to OLS for robustness to extreme values.

groups (high-skilled and low-skilled). To recover $log(w_{Ht})$ and $log(w_{Lt})$, we need to aggregate also wages of different experience groups. We average them using fixed weights equal to the average over 1967-2009 of the experience-group shares in the total of annual full-time working days.

**Relative labor supply.** To compute labor supply measures, the number of days worked by each detailed education (7 levels) and experience (40 levels) group are converted in "efficiency units" before aggregation at broader level (2 levels of education , high -and low-skilled, and 4 levels of experience, 0-10, 10-20, 20-30 and 30-40).

More precisely, we first compute the number of days worked in a given year by the 7 education $\times$ 40 years of real experience groups. These quantities are then converted into efficiency units by multiplying them with weights fixed over the period. These weights are obtained by (1) calculating for each cell and each year the median wage for full-time working periods (2) standardizing them by a reference (the median wage for low vocational degree holders with 15 years of real experience) in the same year, (3) averaging these standardized wages over the period to obtain 7$\times$ 40 fixed efficiency weights.

Efficiency units are then combined to obtain relative labor supply measures. The aggregate high-skilled labor supply is the sum of the university and some college efficiency units, and the aggregate low-skilled labor supply is the sum of the other degrees efficiency units. The log relative labor supply is the log of the ratio between the two. This measure is computed combining both all experience groups (to obtain $log(H_t/L_t)$) and per experience groups (to obtain $log(H_{jt}/L_{jt})$).

Alternatively, we compute the supply measure using the number of workers having worked at least one day during the year rather than worked days to take into account unemployment. In this case, we consider that all workers having worked at least once in the year contribute equally to labor supply.

# 3.B Additional tables

## 3.B.1 Education categories

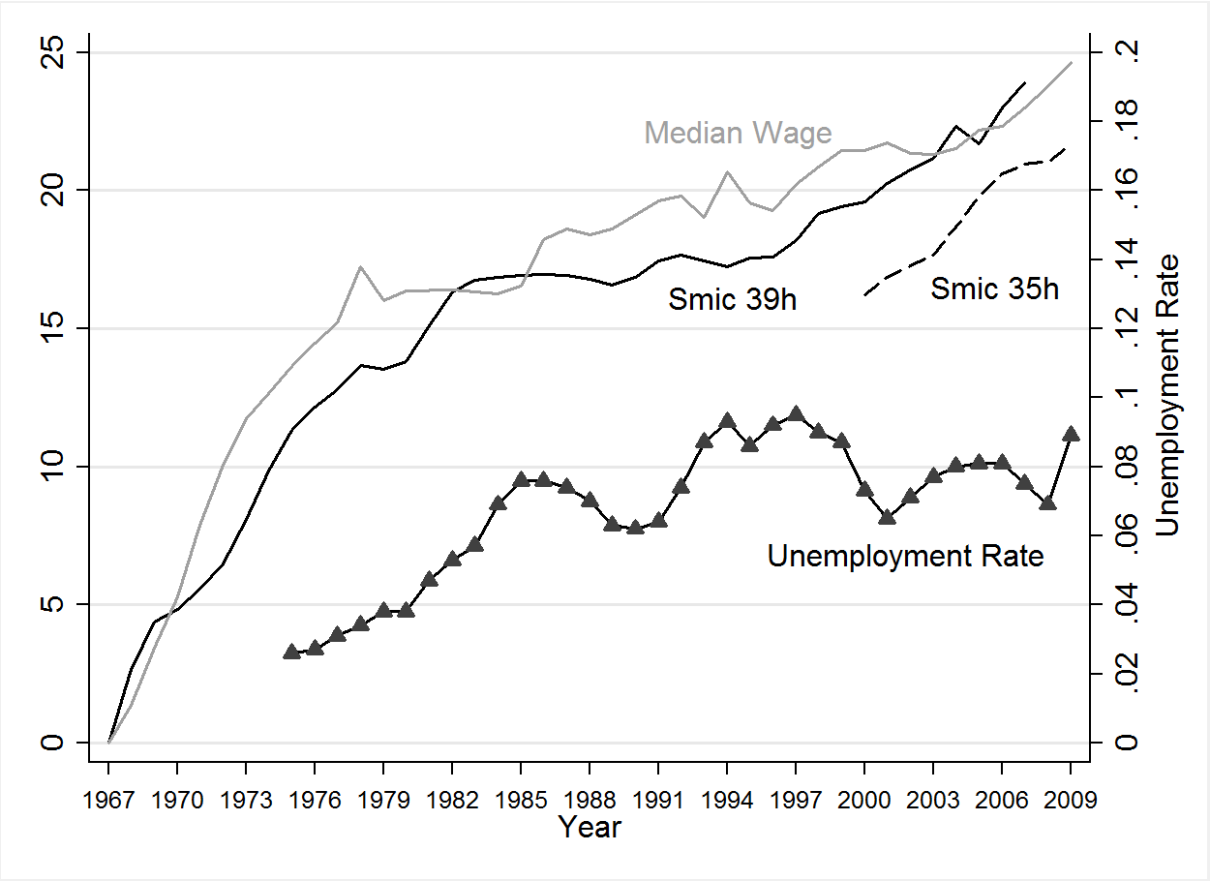
Table 3.5: Education categories

| French label | English label | % (pooled sample) |
|---|---|---|
| Aucun diplôme déclaré or CEP, DFEO | no degree reported or completed elementary school | 0.30 |
| BEPC, BE, BEPS | completed junior high-school | 0.06 |
| CAP, BEP, EFAA, BAA, BPA | basic vocational degree | 0.37 |
| Bac technique et professionnel, Brevet professionnel, autres brevets BEA, BEC, BEH, BEI, BES, BATA, | advanced vocational-technical degree (high vocational) | 0.08 |
| Bac général, brevet supérieur, CFES | completed high-school | 0.03 |
| BTS, DUT, DEST, DEUL, DEUS, DEUG, diplôme professions sociales ou de la santé | some college, college degree and technical or vocational college | 0.09 |
| Dip. universitaire de 2ème ou 3ème cycle, diplôme d'ingénieur, Grandes Ecoles | university degree, engineering school, Grande Ecole | 0.07 |

Source: EDP-DADS Data. 15- to 64-Year-Old Full-Time Men working in the Private Sector.
Note: The information on the degree may differ between Censuses. We favor the one corresponding to the Census that follows the end of studies or when the person has just passed 27. When no degree are declared in that Census or when the information is not precise enough to determine the education category, we use the information reported in the following ones. In the 1968 and the 1990 Censuses, general high-school and vocational high-school are not distinguished. The same occurs for "brevet de technicien" (a vocational high-school degree) and BTS (a post-Bac vocational degree) in the 1968 Census. In the 1968 and the 1975 Censuses, there is no distinction between college and university degrees. In such cases, we use the following Census information when available and choose the most frequent category in the population otherwise.

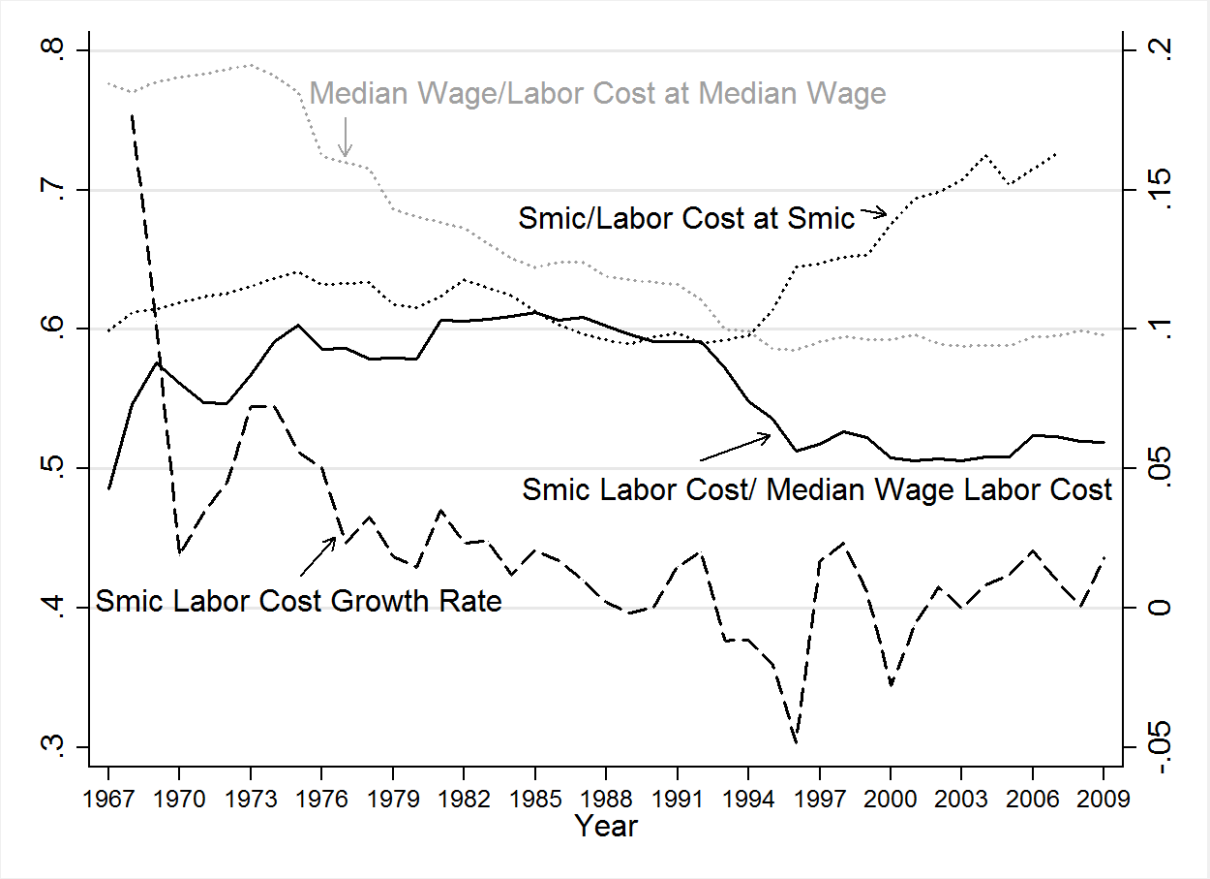
### 3.B.2 Labor market trends

Figure 3.14: Minimum Wage (Smic) and Unemployment Trends.




Source: Median Wage: EDP-DADS data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Minimum Wages (Smic 39h and Smic 35h): French Ministry of Labor.
Note: Median Wage reports the Cumulative Changes since 1967 in Daily Median Wage of Full-Time Male Workers in the Private Sector; Smic 39h (resp. Smic 35h) reports the Cumulative Changes since 1967 in Daily Minimum Wage based on a 39-hour Workweek (resp. 35-hour Workweek). The three wages series are in real terms (en euros 2009), deflated by the French CPI. The Male Unemployment Rate is reported on the right y-axis.

Figure 3.15: Labor cost trends: Minimum Wage vs Median.




Source: Median Wage: EDP-DADS data, 15 to 64-Year-Old Full-Time Male Workers in the Private Sector, weighted by Job Duration. Minimum Wage, Labor Costs: French Ministry of Labor.

Note: Median Wage/Labor Cost at Median Wage (resp. Smic/Labor Cost at Smic) reports ratio of Daily Median Wage (resp. Daily Minimum Wage) on corresponding Daily Firm Total Labor Cost. Smic Labor Cost/Median Wage Labor cost reports the ratio of the Daily Minimum Wage Labor Cost to the Daily Median Wage Labor Cost. Series are in real terms, deflated by the French CPI. The Smic Labor Cost Growth Rate is reported on the right y-axis.

## 3.C Employment zones classification

The most relevant scale to study local labor market in France is the employment zone which is defined by the Insee (French Institute of Statistics) and is equivalent to the US commuting zones or the UK travel-to-work areas. They are zones where the majority of the labor force live and work, and their construction is based on work commuting. The 2010 zoning divides the French metropolitan area (without overseas territories) in 304 zones. Some areas are relatively little populated and do not have enough observations in the EDP-DADS data set to compute our indicators of relative wage and supply by skills with sufficient precision. We therefore group some of the employment zones. This aggregation does not mean that these zones form a unique local labor market but rather assumes that they behave in a similar fashion for the question of interest and thus contribute in the same way to the estimations. An ascending hierarchical clustering is run using the density, the distribution of jobs among industries, the share of retired people and the female labor force participation. This leads to 5 types of zone :

- high density areas, for which the density criteria is the strongest feature
- touristic areas, where hostelling and catering, retail and personal services are important
- agricultural areas, where the agricultural sector is very important, and the share of retired people is also strong
- commodities and energy manufacturing areas
- other manufacturing industries

We use this typology to group low population zones within the same region. There are then 86 grouped employment zones.

# Chapter 4

# Skills, technical change and local labor markets : evidence from France 1990-2011

# Introduction[1]

Similarly to the US, the demand for high-skilled workers relatively to low-skilled workers has increased in France over the last forty years. The main explanations for the US skill-biased shift in labor demand fall roughly into two categories, technology and globalization. In this chapter, we investigate the first one for France.

The technology hypothesis relates the change in demand for skills to the dissemination of Information and Communication Technology (ICT) that are thought to increase the productivity of high-skilled workers more than that of low-skilled workers. For instance, Beaudry et al. (2006) and Beaudry et al. (2010) estimate the effect of PC adoption on labor supply and demand by skills across US metropolitan areas. The effect of technology on jobs has been defined more precisely by Autor et al. (2003) as an automation of routine tasks. Jobs that consist of routine tasks disappear as these tasks can be performed by computer and the price of computers decreases, while abstract or manual tasks remain. Abstract tasks being paid at the top of the wage distribution and manual tasks at the bottom, it may explain the rise in wage inequalities. The automation of routine tasks has also been related to the polarization of the labor market (Autor et al. (2003), Goos et al. (2009) Goos et al. (2014) Michaels et al. (2014) Firpo et al. (2011) Machin and Van Reenen (1998)). The polarization of the labor market is the rise in the proportion of the least and most paid occupations, while the medium-paid ones decline. It is observed in the US and to some extent in Europe and it is important to explain the increase in wage inequalities.

Another explanation relates the rise of wage inequality to imports competition from low-wage countries (Autor et al. (2013a), Rigby et al. (2015)). As trade barriers declined, low-skilled jobs have faced a higher competition than high-skilled jobs, and this could explain a rise in wage inequality by skills. Indeed, as predicted by trade theory and the Stolper-Samuelson theorem, when trading cost decreases, the return on the abundant factor (high-skilled workers relatively to low-skilled workers in developed economies) increases.[2] Another explanation associated to trade is the offshoring of jobs or tasks (Grossman and Rossi-Hansberg (2008)). If certain jobs or tasks can be performed in low-wage countries and the cost of offshoring them decreased (because trade barriers, such as transportation or communication cost, decreased), low-skilled labor demand might have decreased. Note that this phenomenon can partly be related to ICT, in the sense that ICT certainly decreases communication costs.

Recent papers used local labor markets to test for these explanations for the US (Autor and

[1] This chapter is based on a joint work with M. Orand.

[2] Although the effect might be opposite as shown by Lorentowicz et al. (2005) in the case of Austria and Poland.

Dorn (2013), Autor et al. (2013a) and Autor et al. (2013b)). They found that imports competition had an effect on the level of employment at all skill levels. They also found evidence for a Skill-Biased Technical Change (SBTC) in both manufacturing and non-manufacturing sectors and showed that, among routine jobs, the share of jobs in production decreased first and the share of information processing jobs (such as clerical jobs) decreased after.

While these papers used local labor markets mainly as a way to identify a nation-wide phenomenon, another set of papers looked into the spatial component of wage inequalities by skills (Lindley and Machin (2014), Moretti (2013)). They found that a spatial concentration of high-skilled workers occurred, and related it to a skill-biased spatial shift in labor demand. Similar patterns have been documented for France in the previous chapter. Potential explanations for this spatial demand shift could be the initial local industrial mix that made some local labor markets more exposed to SBTC, offshoring or imports competition.

Other mechanisms analyzed by economic geography could also explain this spatial shift. They could be considered as spatial factors as they are related to agglomeration economies and to the cost of distance between locations. Baum-Snow et al. (2014) showed that there has been an increase in agglomeration economies for high-skilled workers in the US. They did not study the cause of this increase, but they relate it to knowledge spillovers, which are often higher for high-skilled workers and may have increased. This skill-biased rise in agglomeration economies would explain a higher concentration and higher wages for high-skilled workers in big and dense cities. Another channel, which in fact links ICT to geography, is the decreasing cost of communication between locations entailed by ICT. Whereas SBTC is related to the information part of ICT, the communication part is also a potential channel.[3] Duranton and Puga (2005) model predicts that a fall in communication cost between headquarters and affiliates, leads to a functional specialization of cities. Some cities specialize in headquarter and business services and other in production activities. Even though their model does not explicitly encompass skills, as headquarter and business services employ more skilled workers, this mechanism could explain that the demand for high-skilled workers have increased more in some cities than other.

Evidence for France is much scarcer than for the US. Aubert and Sillard (2005) and Fontagné and D'Isanto (2013) proposed an assessment of the extent of offshoring but not of its effects on labor wages. Malgouyres (2014) implemented the Autor et al. (2013a) strategy to test for the effect of imports competition in France. He found a negative effect of imports competition on employment. This effect is polarized in the manufacturing sector in which it is much stronger for medium-skilled occupations while it is stronger on low-skilled occupations in the non-manufacturing sector. It is different from the results of Autor et al. (2013a) and Autor et al.

[3] As in fact it is in the case of offshoring.

(2013b) who did not find a polarizing effect of imports competition in the US. As for the SBTC hypothesis in France, at a national level, Goux and Maurin (2000) provided evidence of technical change in France, but of a smaller extent than in the U.S. They found that computers and new production technologies were responsible for a fall of around 15% in the share of unskilled workers (with less than high-school education) in total employment over 1970-1993. Goos et al. (2009) studied the distribution of employment between occupations in Europe and fond evidence of job polarization in France between 1993-2006. Machin and Van Reenen (1998) used a panel on seven OECD countries between 1973 and 1989, including France, and found a significant association between skill-upgrading and R&D intensity. Caroli and Van Reenen (2001) find evidence of a skill-biased organizational change in France (and in the UK). They showed that new form of organization of firms, with less layers, are more favorable to high-skilled workers. One of the potential factor of this delayering could be the decreasing in communication costs induced by ICT. To sum up, for France, there is some evidence regarding the link between ICT and the demand for high-skilled relatively to low-skilled workers but only before the 1990's. For the recent period, there is some evidence that the share of high-skilled jobs and of the least paid low-skilled jobs increased in France, but it has not been related to ICT and there is no evidence on the ICT impact at the level of local labor markets.

In this chapter, we document the spatial dynamics in occupations in France since the 1980s and use local labor markets to test whether there has been a decline in routine tasks and an increase in manual and abstract tasks that would confirm the routine task automation hypothesis of Autor and Dorn (2013). More precisely, the main purpose of Autor and Dorn (2013) was to test whether the polarization of jobs observed in the US is due to non-neutral technical change. The idea is that repetitive and more easily codified jobs have been automated due to ICT, whereas in-person services such as food services, house cleaning or home care services have not been much impacted by ICT. They formalized this intuition in a theoretical model. The production of the final good use abstract and routine tasks. Abstract tasks are complement to routine tasks, which can be performed by either computer or labor. The production of services requires only labor performing manual tasks. High-skilled workers perform abstract tasks and low-skilled workers can perform routine or manual tasks. Because consumers like to consume both goods and services, when computer capital price falls, computer capital substitutes to low-skilled workers for routine tasks in the production of the final good and low-skilled workers switch from the final good sector to the service sector. As these services are non-storable and non-tradable, low-skilled workers must be located where services are consumed. The idea of Autor and Dorn (2013) was therefore to use spatial differences in local labor markets to test the routine task automation hypothesis. They applied their model in a spatial setting in which high-skilled labor are mobile between labor markets, whereas low-skilled workers are immobile. The

model gives predictions about the effect of technical change on local labor markets, according to their initial distribution of routine tasks and they test them on US data. More precisely, the model predicts four spatial dynamics of labor market outcomes following a fall in computer capital price :

1. zones where routine jobs are initially more numerous have the largest decreases in routine jobs;
2. in-person service jobs increases where the share of routine jobs is initially higher as low-skilled workers are reallocated from routine jobs to in-person service jobs;
3. abstract jobs increase more in the zones with a high initial routine level because of their complementarity with ICT capital;
4. wages in manual or abstracts jobs increase more in the zones with a high initial routine level.

Using US data, their empirical analysis focused mainly on the second prediction as it is related to the polarization of jobs, which is the main stylized fact they documented and wished to explain. They found that the share of in-person jobs did increase more in the local labor markets where the share of routine jobs was initially higher. As regards France, evidence of the polarization of jobs is less strong. This might be due either to the fact that SBTC and routine task automation are not relevant for the French case or, that the mechanisms are slightly different. In this chapter, we test the Autor and Dorn (2013) predictions for France. Moreover, Autor et al. (2013b) found that among routine occupations, the decrease in clerical and low-skilled production jobs did not occur at the same period of time. In other words, the automation of production tasks and of information-processing tasks did not take place simultaneously. Information-processing tasks are performed in clerical jobs, which are mostly support jobs. It therefore seems that the effects for support and production functions might be different. This can be related quite straightforwardly to the model of Duranton and Puga (2005), which describes another potential effect of ICT on spatial disparities, but through the fall in communication costs rather than in information costs. It shows that this leads to an increase in the functional specialization of cities, namely some cities specialize in headquarter and business services, i.e. support functions. If that is the case, technical change might impact local labor markets differently depending on whether they are specialized in support or production activities. This might explain different results on production or support routine jobs. Technically, the automation of clerical and manufacturing functions might also be of a different nature. An addition of our analysis to that of Autor and Dorn (2013) is to examine whether accounting

for the differences in the function of routine jobs (production versus support), gives valuable insights.

Section 1 presents data issues and our empirical strategy. Section 2 depicts some descriptive statistics. Results are shown in section 3 and some robustness checks are conducted in section 4.

## 4.1 Data issues and empirical strategy

For our empirical analysis, we need to measure job contents. Therefore, we rely on information about the occupations of workers.[4] Note that, in this chapter, skills and occupational classifications refer to jobs while education levels refer to workers : for instance, workers with different education levels can be found within the high-skilled occupation group.

We define local labor markets similarly to the previous chapter. We use the employment zones that are based on commuting information.[5] This is very similar to the concept of Commuting Zones used in Autor and Dorn (2013). Note that, in the theoretical model, low-educated workers are immobile between these zones while high-educated workers are mobile. This seems a strong assumption, but one can argue that the model is still valid if high-educated workers are more mobile than low-educated workers, which is a far less strong assumption.

Data sets with detailed information and enough observations at that geographical level are not very numerous. Moreover, since many in-person service jobs are performed by self-employed, it is preferable not to rely on wage earners databases such as the one used in the previous chapters. We therefore use the one fourth samples of the French 1982, 1990 and 1999 Censuses and the 2006 and 2011 census surveys and in particular detailed information about occupations (at the 4-digit level) and on unemployment status.

There is also information on the level of education and we separate education levels between college (post secondary education) and non-college workers (high-school degree or less) to disentangle between high and low-educated workers. A drawback of the French censuses is that there is no information on wages or earnings. We therefore focus our analysis on the Autor and Dorn (2013) model predictions on routine, service and high-skilled jobs. We present next how we define these occupations on French data and also how we define support and production functions as needed for our addition to Autor and Dorn (2013) model.

[4]The information on the industry they worked in is not used, although the local industry mix is used for robustness checks.

[5]But we do not need to group them as there are enough observations in the data set used in this chapter.

### 4.1.1 Tasks and occupations

For the sake of clarity, we group occupations in seven groups. We define high-skilled occupations as managers, executives and engineers (tables 4.19 and 4.20 in appendix) and we split low and medium-skilled occupations in the following groups : workers in production and craft, manufacturing workers, clerical jobs, retail jobs, service occupations and workers performing tasks related to transport, construction or farming.[6] More precisely, (low-skilled) service occupations are occupations in food service, health service (except doctors and pharmacists), home and personal care (table 4.21 in appendix). At a national level, high-skilled and service occupations shares increased between 1982 and 2011, the share of manufacturing workers and transport-construction-farming occupations decreased, while there are no evolutions of the other occupation groups (table 4.1).

Table 4.1: Evolution of the distribution of major occupation groups

| | 1982 | 1990 | 1999 | 2011 |
|---|---|---|---|---|
| Managers/executives/engineers | 0.13 | 0.16 | 0.18 | 0.20 |
| Production/craft workers | 0.11 | 0.10 | 0.10 | 0.10 |
| Transport/construction/farming | 0.15 | 0.12 | 0.10 | 0.09 |
| Manufacturing workers | 0.17 | 0.14 | 0.12 | 0.10 |
| Retail | 0.16 | 0.17 | 0.16 | 0.15 |
| Clerical | 0.09 | 0.09 | 0.10 | 0.11 |
| Service occupations | 0.19 | 0.21 | 0.25 | 0.25 |

Source : French Censuses, metropolitan France

We also characterize occupations according to their routine intensity. We build a transition matrix between US and French occupations classification (4-digit level 1982 classification).[7] Then, we use the database of Autor and Dorn (2013) on task contents by US occupations and attribute a content in routine, manual and abstract tasks to each French occupation. Doing this, we assume that the content of jobs is not too much different between France and the US. In a similar way to Autor and Dorn (2013), we built a Routine Task Intensity (RTI) index (equal to log(routine task) -log(manual task)-log(abstract task)). Table 4.2 shows the resulting content in the three types of task and the resulting Routine Task Intensity index by major occupation group. According to this measure, clerical and manufacturing occupations are the most routine intensive. These two groups can be related to our two types of functions : support and production. Clerical occupations are notably more intensive in routine tasks. Similarly to Autor and Dorn (2013), we classify the one third of 4-digit level occupations with the highest routine

[6] It is similar as Autor and Dorn (2013), but we separate clerical from retail occupations.

[7] For the 2006 and 2011 censuses, we use a transition table between 1982 and 2003 occupations classification.

index in the 1982 distribution of jobs as routine occupations.[8] Note that the classification as a routine occupation is independent of our previous classification in 7 groups, so they might slightly overlap.

Table 4.2: Task intensity of major occupation groups in 1982

| | Abstract tasks | Routine tasks | Manual tasks | RTI index |
|---|---|---|---|---|
| Managers/executives/engineers | + | − | − | − |
| Production/craft workers | − | + | + | − |
| Transport/construction/farming | − | − | + | − |
| Manufacturing workers | − | + | + | + |
| Retail | + | − | − | − |
| Clerical | − | + | − | ++ |
| Service occupations | − | − | + | − |

Source : 1982 French Census, metropolitan France, Autor and Dorn (2013) database of task intensity by occupations.

Note: (+) indicates a task value above average across all occupations in 1982 weighted by employment and (-) below average.

Last, we classify all occupations in "support" or "production" occupations. We define management and administrative functions as support occupations (see appendix 4.A for details) and the remainder as production functions. We then split the routine occupations group in support routine occupations and production routine occupations. Table 4.3 shows the distribution of the share of routine occupations in employment by employment zone in 1982. Across employment zones, the share in routine occupations is higher in the north of France, in the Paris region and in some cities such as Nantes or Nice. Next columns in table 4.3 distinguishes between support routine occupations and production routine occupations. They are very differently distributed across space. The share of support routine occupations is higher in the Paris region, in the South-East and in large cities. The share of production routine occupations is higher in the North and the East and in some central areas.

### 4.1.2 Empirical setting

Our main variables of interest are the share in employment of routine occupations, service occupations and high-skilled occupations. The Autor and Dorn (2013) model states that, across local labor markets, when computer price decreases, we should observe an increase in the employment share of service occupations and high-skilled occupations and that this increase should

[8]The most frequent occupations in this group are : secretaries, administrative employees, finance and accounting employees, public employees.

Table 4.3: Share of routine occupations by employment zone in 1982

| Share of routine occupations by employment zone | | | | | |
|---|---|---|---|---|---|
| all | | production | | support | |
| Mean | 30% | Mean | 17% | Mean | 13% |
| Standard Error | 5% | Standard Error | 4% | Standard Error | 4% |
| Q3 | 34% | Q3 | 19% | Q3 | 15% |
| Median | 30% | Median | 16% | Median | 13% |
| Q1 | 27% | Q1 | 14% | Q1 | 10% |
| Highest 10 | | Highest 10 | | Highest 10 | |
| *Lille* | 40% | *Charolais* | 25% | *Poissy* | 23% |
| *Saint-Dié-des-Vosges* | 41% | *Vallée de la Bresle-Vimeu* | 27% | *Roissy - Sud Picardie* | 24% |
| *Créteil* | 41% | *Roubaix-Tourcoing* | 27% | *Versailles* | 24% |
| *Saint-Omer* | 41% | *Cholet* | 28% | *Evry* | 25% |
| *Marne-la-Vallée* | 41% | *Longwy* | 28% | *Saclay* | 25% |
| *Paris* | 41% | *Les Herbiers* | 30% | *Orly* | 26% |
| *Orly* | 41% | *Saint-Dié-des-Vosges* | 30% | *Cergy* | 26% |
| *Remiremont* | 42% | *Saint-Omer* | 30% | *Marne-la-Vallée* | 26% |
| *Roubaix-Tourcoing* | 46% | *Remiremont* | 32% | *Paris* | 26% |
| *Vallée de l'Arve* | 46% | *Vallée de l'Arve* | 35% | *Créteil* | 27% |
| Lowest 10 | | Lowest 10 | | Lowest 10 | |
| *Ghisonaccia-Aléria* | 12% | *Ghisonaccia-Aléria* | 6% | *Ghisonaccia-Aléria* | 6% |
| *Saint-Flour* | 16% | *Corte* | 8% | *Saint-Flour* | 7% |
| *Carhaix-Plouguer* | 16% | *Saint-Flour* | 9% | *Carhaix-Plouguer* | 7% |
| *Porto-Vecchio* | 17% | *Porto-Vecchio* | 9% | *Mauriac* | 7% |
| *Mauriac* | 18% | *Carhaix-Plouguer* | 9% | *Segré* | 7% |
| *Loudéac* | 19% | *Lannion* | 10% | *Avranches* | 7% |
| *Calvi-L'Ile-Rousse* | 20% | *Loudéac* | 10% | *Brioude* | 8% |
| *Lannion* | 20% | *Mauriac* | 10% | *Sablé-sur-Sarthe* | 8% |
| *Avranches* | 20% | *Guingamp* | 11% | *Porto-Vecchio* | 8% |
| *Guingamp* | 20% | *Ajaccio* | 11% | *La Flèche* | 8% |

Source : 1982 French Census, metropolitan France, Autor and Dorn (2013) database of task intensity by occupations.

be positively correlated to the initial share of routine occupations. A decrease in routine occupations should occur and should be stronger where the initial share of routine occupations is higher. Because of the French context of high unemployment, we suspect that low-skilled unemployment behaves like the employment share in service occupations as low-skilled workers can switch from routine occupations to either service occupations or unemployment. We may therefore also find an increase in low-skilled unemployment positively correlated to the initial share of routine occupations across local labor markets.

We implement our analysis on changes of our variables of interest between 1990 and 2011, as before that period ICT was not much spread in France. Our main explanatory variable is the initial share of routine occupations in employment in each employment zone. The initial share of routine occupations relates in the theoretical framework to the production technology of the zone, Autor and Dorn (2013) argue that the empirical measure must reflect the 'long run, quasi-fixed component of their industrial structure '. We therefore decide to take the 1982 level of the share of routine occupations rather than the 1990 one as our "initial share of routine occupations". The 1982 measure, anterior to the period of study and to the bulk of ICT dissemination, is less likely to be correlated to shocks between 1990 and 2011. Autor and Dorn (2013) also implemented an IV strategy to address this issue and found similar results, sometimes larger. We cannot implement this strategy as we do not have the same information (they use 1950 local industry structure). We have therefore to keep in mind that there might be a small downward bias in our results. Finally, we propose an extension by splitting the 1982 share of routine occupations between the 1982 employment share of production routine occupations and the 1982 employment share of support routine occupations.

The main issue regarding the interpretation of the results is related to the fact that the share of routine occupations in 1982 might be correlated to other factors that could explained the evolutions of the distribution of occupations and are not in the theoretical model. To address this concern, we provide a robustness analysis to check that our results remain valid when adding controls for other potential factors.

## 4.2 Descriptive statistics

### 4.2.1 Trends in the spatial distribution of occupations

Before testing the effect of the initial share of routine occupations on the changes in our variables of interest (share of routine occupations, service occupations and high-skilled occu-

pations) over 1990-2011 across French local labor markets, we describe briefly their dynamics as they have not been much documented.

Table 4.4: Share of routine occupations by employment zone in 1990 and 2011

| Share of routine occupations by employment zone | | | |
|---|---|---|---|
| 1990 | | 2011 | |
| Mean | 33% | Mean | 31% |
| Standard Error | 4% | Standard Error | 2% |
| Q3 | 36% | Q3 | 33% |
| Median | 33% | Median | 31% |
| Q1 | 30% | Q1 | 30% |
| Highest 10 | | Highest 10 | |
| *Roissy - Sud Picardie* | 41% | *Orly* | 36% |
| *Cergy* | 41% | *Ajaccio* | 36% |
| *Créteil* | 41% | *Vallée de la Bresle-Vimeu* | 36% |
| *Paris* | 41% | *Créteil* | 36% |
| *Vallée de la Bresle-Vimeu* | 42% | *Cergy* | 36% |
| *Marne-la-Vallée* | 42% | *Marne-la-Vallée* | 37% |
| *Orly* | 42% | *Roubaix-Tourcoing* | 38% |
| *Saint-Omer* | 43% | *Longwy* | 38% |
| *Roubaix-Tourcoing* | 45% | *Thionville* | 38% |
| *Vallée de l'Arve* | 48% | *Vallée de l'Arve* | 39% |
| Lowest 10 | | Lowest 10 | |
| *Ghisonaccia-Aléria* | 19% | *Saint-Flour* | 24% |
| *Saint-Flour* | 20% | *Loudéac* | 24% |
| *Carhaix-Plouguer* | 21% | *Mauriac* | 24% |
| *Loudéac* | 21% | *Carhaix-Plouguer* | 25% |
| *Mauriac* | 22% | *Pauillac* | 25% |
| *Ploermel* | 24% | *Ghisonaccia-Aléria* | 25% |
| *Morvan* | 24% | *Thiérache* | 26% |
| *Pauillac* | 24% | *Pontivy* | 26% |
| *Pontivy* | 25% | *Morvan* | 26% |
| *Brioude* | 25% | *Calvi-L'Ile-Rousse* | 26% |

Source : 1990 and 2011 French Census, metropolitan France, Autor and Dorn (2013) database of task intensity by occupations.

Figures 4.4, 4.6 and 4.5 show the share of routine, high-skilled and service occupations within employment zone in 1990 and 2011. A first observation is that routine and service occupations are not located in the same employment zones. The share of service occupations is high on the Atlantic and Mediterranean coasts and in some rural areas. The share of routine occupations has decreased over 1990-2011 and seems to be more evenly distributed in 2011 than in 1990. Indeed, when regressing 1990-2011 change on 1990 level (table 4.7), there is a significant negative relationship, meaning a convergence in the level of the share of routine occupations among employment zones. And this is also true when separating between college and non-college employment. The share of high-skilled occupations is higher in large cities and all the more in 2011

Table 4.5: Share of service occupations by employment zone in 1990 and 2011

| Share of service occupations by employment zone | | | |
|---|---|---|---|
| 1990 | | 2011 | |
| Mean | 22% | Mean | 28% |
| Standard Error | 3% | Standard Error | 3% |
| Q3 | 23% | Q3 | 30% |
| Median | 22% | Median | 28% |
| Q1 | 20% | Q1 | 26% |
| Highest 10 | | Highest 10 | |
| *Ussel* | 27% | *Le Blanc* | 33% |
| *Le Blanc* | 27% | *Saint-Amand-Montrond* | 33% |
| *Corte* | 28% | *Verdun* | 33% |
| *Céret* | 28% | *Honfleur* | 34% |
| *Honfleur* | 28% | *Saint-Girons* | 34% |
| *Berck-Montreuil* | 30% | *Calvi-L'Ile-Rousse* | 34% |
| *Calvi-L'Ile-Rousse* | 30% | *Ussel* | 34% |
| *Prades* | 31% | *Prades* | 34% |
| *Brianon* | 33% | *Berck-Montreuil* | 35% |
| *Menton Vallée de la Roya* | 34% | *Menton Vallée de la Roya* | 36% |
| Lowest 10 | | Lowest 10 | |
| *Vallée de l'Arve* | 13% | *Vallée de l'Arve* | 19% |
| *Morteau* | 14% | *Morteau* | 19% |
| *Saint-Claude* | 15% | *Rambouillet* | 20% |
| *Oyonnax* | 16% | *Saint-Quentin-en-Yvelines* | 20% |
| *Les Herbiers* | 16% | *Paris* | 20% |
| *Wissembourg* | 17% | *Oyonnax* | 21% |
| *Thiers* | 17% | *Saclay* | 21% |
| *Vallée de la Bresle-Vimeu* | 17% | *Saint-Claude* | 21% |
| *Epernay* | 18% | *Les Herbiers* | 22% |
| *Ambert* | 18% | *Wissembourg* | 22% |

Source : 1990 and 2011 French Census, metropolitan France, Autor and Dorn (2013) database of task intensity by occupations.

Table 4.6: Share of high-skilled occupations by employment zone in 1990 and 2011

| Share of high-skilled occupations by employment zone | | | |
|---|---|---|---|
| 1990 | | 2011 | |
| Mean | 12% | Mean | 15% |
| Standard Error | 3% | Standard Error | 4% |
| Q3 | 13% | Q3 | 17% |
| Median | 11% | Median | 14% |
| Q1 | 10% | Q1 | 13% |
| Highest 10 | | Highest 10 | |
| *Cergy* | 20% | *Grenoble* | 26% |
| *Créteil* | 20% | *Toulouse* | 28% |
| *Lille* | 20% | *Aix-en-Provence* | 28% |
| *Montpellier* | 21% | *Poissy* | 29% |
| *Aix-en-Provence* | 22% | *Lille* | 29% |
| *Paris* | 23% | *Versailles* | 30% |
| *Versailles* | 23% | *Rambouillet* | 32% |
| *Saint-Quentin-en-Yvelines* | 24% | *Saclay* | 35% |
| *Rambouillet* | 26% | *Saint-Quentin-en-Yvelines* | 36% |
| *Saclay* | 28% | *Paris* | 40% |
| Lowest 10 | | Lowest 10 | |
| *Mayenne* | 7% | *Péronne* | 9% |
| *L'Aigle* | 7% | *Mauriac* | 10% |
| *Morteau* | 7% | *Loudéac* | 10% |
| *Louhans* | 7% | *Louhans* | 10% |
| *Ghisonaccia-Aléria* | 7% | *Chatillon* | 10% |
| *Wissembourg* | 8% | *Saint-Flour* | 10% |
| *Vitré* | 8% | *Brioude* | 10% |
| *Segré* | 8% | *Jonzac-Barbezieux-Saint Hilaire* | 10% |
| *Loudéac* | 8% | *Les Herbiers* | 10% |
| *Nogent-le-Rotrou* | 8% | *Vallée de la Bresle-Vimeu* | 10% |

Source 1990 and 2011 French Census, metropolitan France, Autor and Dorn (2013) database of task intensity by occupations.

than in 1990 (table 4.8). We do not present the results on high-skilled occupations separately for college and non-college workers as non-college workers in high-skilled occupations are not very numerous. Lastly, the share of service occupations has increased in most employment zones over 1990-2011. For non-college employment, there is a negative relationship between the 1990-2011 change and the 1990 level, meaning also a convergence between employment zones. For college employment in service occupations, the effect is not significant. For the remainder of the chapter, we focus on the share of service occupations in non-college employment as Autor and Dorn (2013) prediction on service occupations relates to low-educated workers and for the sake of comparison with their results.

Table 4.7: 1990-2011 spatial dynamics of the share of routine occupations in employment

| | 1990-2011 change in the share of routine occupations | | |
|---|---|---|---|
| | employment share | college empl. share | non college empl. share |
| 1990 initial level | $-0.467^{***}$ | $-0.445^{***}$ | $-0.395^{***}$ |
| | $(0.015)$ | $(0.021)$ | $(0.098)$ |
| Observations | 304 | 304 | 304 |

Source : 1990 and 2011 French Censuses, metropolitan France

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. For each outcome, the change between 1990 and 2011 is regressed on its own level in 1990. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

Table 4.8: 1990-2011 spatial dynamics of the share of high-skilled and service occupations in employment

| | | 1990-2011 change in | |
|---|---|---|---|
| | empl. share of of high-skilled occ. | college empl. share of service occupations | non-college empl. share of service occupations |
| 1990 initial level | $0.756^{***}$ | $-0.025$ | $-0.227^{***}$ |
| | $(0.243)$ | $(0.146)$ | $(0.042)$ |
| Observations | 304 | 304 | 304 |

Source : 1990 and 2011 French Censuses, metropolitan France.

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. For each outcome, the change between 1990 and 2011 is regressed on its own level in 1990. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

### 4.2.2 Routine occupations and ICT

The predictions of Autor and Dorn (2013) model are based on the fact that ICT can be used to perform routine tasks. Before testing these predictions, we therefore assess whether there is

a link between the initial routine level of a local labor market and the following dissemination of ICT in the zone. We do not have access to a local measure of ICT capital or other measures of ICT dissemination but we have the national evolution of ICT capital stock by industry and the employment composition by industry for each zone. We therefore build for each zone an "ICT dissemination exposure" index, with a method similar to the imports competition exposure index of Autor et al. (2013b). We compute for 1990 and 2011 and each industry the national level of ICT capital normalized by the 1982 level of employment. We use the 1982 level of employment rather than the current level as the current level is probably correlated to ICT capital. For each local labor market and each year, we then apply this national ICT capital per 1982 worker and per industry to the 1982 local employment distribution by industry. This gives an estimation of what would have been the local level of ICT if the employment structure by industry have remained the one of 1982 and the local evolution by industry has been the same as the national one. The change between 1990 and 2011 of this index is a measure of how much the employment of a zone was exposed to ICT dissemination because of its 1982 employment distribution by industry (see appendix 4.B for details). Hereafter, we refer to it as the "1990-2011 change in ICT exposure". An advantage of this measure is that it is more exogenous than an actual measure of the local level of ICT. It does not take into account the fact that, within an industry, some zones might have adopted more or less ICT due to unobservable characteristics that could be correlated to our variables of interest and thus biasing the estimations.

As the routine task automation hypothesis states that places where many routine tasks were performed should have adopted ICT more quickly, there should be a positive correlation between ICT dissemination and initial routine level of employment zones. Column (1) of table 4.9 shows that indeed employment zones with a higher share of routine occupations in 1982 were exposed to a significantly higher 1990-2011 change in ICT exposure. In columns (2) and (3) of table 4.9, we test this relationship on support and production routine occupations separately. the 1990-2011 change in ICT exposure is significantly related to the initial share of support routine occupations, but not to the initial share of production routine occupations. Given how the measure was built, it means that the industries with a high 1982 share of routine production jobs did not experience more or less ICT capital development than those with a low 1982 share of routine production jobs. It may be that technical change did not happen under the form of ICT capital in production activities. On the contrary, industries with a high 1982 share of support routine jobs, experienced a higher development of ICT capital. This furthermore justifies the distinction between support and production routine occupations in the analysis we are conducting afterwards.

Table 4.9: Initial share of routine occupations in employment and 1990-2011 change in ICT exposure by employment zone

| | 1990-2011 change in ICT exposure | | |
|---|---|---|---|
| 1982 share of routine occ. | $1.792^{***}$ | $1.991^{***}$ | $-0.427$ |
| | $(0.282)$ | $(0.145)$ | $(0.388)$ |
| Type of routine occ. | all | support | production |
| Observations | 304 | 304 | 304 |

Source : 1990 and 2011 French Censuses, metropolitan France, Insee.fr for ICT capital

Note: Standard errors in parentheses. ICT in thousand of euros. The change in ICT exposure is computed using the national change in ICT capital by worker by industry and weighting for each employment zone by the 1982 local employment share by industry. Estimations are weighted by 1982 employment zone population.

* $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

## 4.3 A test of the automation hypothesis on French data

We have found evidence that ICT dissemination might be related to a decrease in routine jobs. We now turn to tests of the Autor and Dorn (2013) model predictions in the French case.

Table 4.10: Effect of initial share of routine occupations on 1990-2011 change in labor market outcomes by employment zone

| | 1990-2011 change in | | | |
|---|---|---|---|---|
| | empl. share of routine occupations (1) | empl. share of high-skilled occupations (2) | non college empl. share of service occupations (3) | non college unemployment rate (4) |
| 1982 share of routine occ. | $-0.353^{***}$ | $0.482^{**}$ | $0.100^{***}$ | $0.266^{***}$ |
| | $(0.014)$ | $(0.229)$ | $(0.025)$ | $(0.040)$ |
| Observations | 304 | 304 | 304 | 304 |

Source : 1982, 1990 and 2011 French Censuses, metropolitan France

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

We have seen in the previous section that the share of routine occupations decreased more over 1990-2011 in zones where it was high in 1990. As we explained previously, we prefer to use the 1982 level rather than the 1990 one as our initial point for the test of Autor and Dorn (2013) predictions. We therefore check that the share of routine occupations decreased more over 1990-2011 for zones where this share was high in 1982 (column (1) of table 4.10). We next regress the 1990-2011 change in the share of high-skilled occupations in employment and

in the share of service occupations in non-college employment on the 1982 share of routine occupations by employment zones. Results are presented respectively in columns (2) and (3) of table 4.10. As predicted by the model, the share of high-skilled occupations has increased more where the share of routine occupations was initially higher, with a positive and statistically significant link. Similarly, the positive and significant link between change in the share of service occupations in non-college employment between 1990 and 2011 and the initial share of routine occupations tends to validate the model of Autor and Dorn (2013).

Lastly, in the theoretical model, the transfer from routine to in-person service jobs relies on the fact that low-skilled workers are immobile inside their local labor market. In the French context of high unemployment and higher minimum wage, this hypothesis could translate in low-skilled workers moving to unemployment rather than to in-person service jobs, in particular if the demand for in-person services was not strong enough. We therefore test the impact of the initial share of routine occupations on non-college unemployment rate. Column (4) of table 4.10 shows a significant positive relationship between the initial share of routine occupations and non-college unemployment. So it seems that in the French case, when routine jobs declined, some low-skilled workers have switched to service occupations and others have become unemployed.

The hypothesis of a non-neutral technical change leading to routine task automation seems validated in the French case. We also investigate whether the result holds for the two types of routine tasks, support and production, to test if the task automation mechanism remains valid, when we take into account other mechanisms such as those described in Duranton and Puga (2005). Indeed, using French data to compute the measure of functional specialization used by Duranton and Puga (2005) for the US, we find that big cities seem to have specialized in support functions and small cities in production functions which entails that this mechanism is probably relevant (figure 4.11) for France.

Table 4.12 presents the same estimations as in the previous section but splitting the initial share of routine occupations into production and support occupations. The share of each type of routine occupations has decreased more in the zones where it was higher. Our results for the share of service occupations in non-college employment and non-college unemployment hold : they have increased more in the zones where the 1982 share of production routine occupations or the 1982 share of support routine occupations was initially high. The share of high-skilled occupations has increased more in zones where the initial share of support routine occupations was higher but not in the zones where the initial share of production routine occupations was higher. This last result contradicts the predictions of Autor and Dorn (2013). It could mean that there is no complementarity between routine production tasks and abstract tasks, but an

Table 4.11: Functional specialization by employment zone in 1990 and 2011

| | Functional specialization in management against production | |
|---|---|---|
| Local population | 1990 | 2011 |
| $< 50\,000$ | -0.52 | -0.52 |
| 50 000-100 000 | -0.44 | -0.50 |
| 100 000-250 000 | -0.36 | -0.38 |
| 250 000-500 000 | -0.17 | -0.19 |
| 500 000-1 000 000 | 0.04 | 0.08 |
| 1 000 000-2 000 000 | 0.41 | 0.57 |
| $> 2\,000\,000$ | 1.36 | 3.49 |

Source : 1990 and 2011 French Censuses, metropolitan France

Note: This measure is similar to the ones= used in Duranton and Puga (2005). It is the percentage difference from the national average of executives and managers per production worker (occupied in precision production, fabrication or assembly). The last category (more than 2 million people) contains only one employment zone, Paris.

other credible hypothesis is that this complementarity does not require geographical proximity, and even less as ICT develops and communication cost decreases. If this is the case, the lack of geographical proximity requirement seems more valid for production than for support functions.

For non-college workers, the impact of the initial share of routine occupations has been stronger on unemployment rate than on the share of service occupations. The higher disappearance of routine occupations in zones with a higher initial level of the share of routine occupations seems to have led to a higher increase of non-college unemployment rather than of non-college employment in service occupations. Moreover, the effect on the share of services occupations is stronger for production rather than support routine occupations. So it seems that the demand for service occupations was less important in zones with routine support jobs than in zones with routine production jobs. In Autor and Dorn (2013) theoretical model, results for low-skilled workers are driven by their immobility and the consumer demand for services. The fact that there is a smaller effect on service occupations in the places where the share of high-skilled occupations has increased the most, entails that in, France, the demand for service occupations may not have been due to local workers. In other words, the rise in the demand for service occupations might not have been driven by local workers consumption.[9] Given the places where the rise in service occupations took place, it is more likely to have been due to the aging of the population or to tourism. This would be a demand induced by consumers who were not in the labor force (retired people) or who did not work in theses places (tourists).

[9]The hypothesis of a skill-biased consumption to explain the skill-biased shift in demand is then less credible.

Table 4.12: Effect of the initial share of production and support routine occupations on 1990-2011 change in labor market outcomes by employment zone

| | 1990-2011 change in | | | | |
|---|---|---|---|---|---|
| | empl. share of prod. routine occupations | empl. share of sup. routine occupations | empl. share of high-skilled occupations | non college empl. share of service occup. | non college unemployment rate |
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of production routine occ. | $-0.444^{***}$ | $0.028^{*}$ | $-0.001$ | $0.147^{***}$ | $0.223^{***}$ |
| | $(0.022)$ | $(0.015)$ | $(0.035)$ | $(0.023)$ | $(0.030)$ |
| 1982 share of support routine occ. | $-0.050^{***}$ | $-0.285^{***}$ | $0.621^{***}$ | $0.087^{**}$ | $0.279^{***}$ |
| | $(0.010)$ | $(0.015)$ | $(0.213)$ | $(0.037)$ | $(0.042)$ |
| Observations | 304 | 304 | 304 | 304 | 304 |

Source : 1982, 1990 and 2011 French Censuses, metropolitan France.

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

## 4.4 Other explanations of the skill-biased spatial shift in labor demand

In this section, we test the robustness of our results to other potential explanations of the skill-biased spatial shift in labor demand. First we test the results for low-educated workers. The internationalization of trade is the main alternative explanation to the decrease of demand for low-educated workers. A first channel is through offshoring : it has become cheaper to perform some tasks in other countries, in general low-wage countries. The offshorability of an occupation is possibly correlated to its intensity in routine tasks as easily codified tasks may also be easily offshored. By way of contrast, service occupations are not easily offshorable : they have been defined precisely by the need to be performed where the consumer is located. Autor and Dorn (2013) use a measure of the offshorability of job based on two variables of the US Department of Labor's Occupational Information Network database : Face-to-Face contact and On-site job."The measure captures the degree to which an occupation requires either direct interpersonal interaction or proximity to a specific work location." We use their database to compute a similar measure for French occupations. Table 4.13 shows that the occupations with the highest level of offshorability are clerical occupations. Low-skilled manufacturing occupations are not considered much offshorable with this measure. We then average the level of offshorability in each zone across occupations and we use the 1982 level of this average for our robustness check. Across employment zones, this measure is positively correlated to the 1982 level of the share of support routine occupations, but not to the 1982 level of the share of production routine occupations.

Table 4.13: Offshorability of major occupation groups

| | Offshorability index |
|---|---|
| Managers/executives/engineers | − |
| Production/craft workers | + |
| Transport/construction/farming | + |
| Manufacturing workers | − |
| Retail | − |
| Clerical | ++ |
| Service occupations | − |

Source : 1982 French Census, metropolitan France, Autor and Dorn (2013) database of offshorability by occupations.

Note: (+) indicates a task value above average across all occupations in 1982 weighted by employment and (-) below average.

A second channel of the impact of globalization on labor demand by skills is through imports competition. Globalization might have induced higher imports competition for industries employing low-skilled workers and thus a decrease in the demand for these jobs, that are possibly routine jobs if imports competition occurred for manufacturing goods for example. We construct a measure of exposure to imports competition for each employment zone, very similarly to the measure used in Autor et al. (2013a) and to our previous ICT dissemination exposure index. More precisely, we apply the national level of imports per employment per industry to the 1982 employment per industry in each employment zone. We then use the 1990-2011 change in this measure of imports competition exposure. It measures how much the 1982 local employment structure by industry was exposed to imports competition, given how imports evolved nationally between 1990 and 2011 (see appendix 4.B for details). Table 4.14 shows that this measure is positively and significantly correlated to 1982 share of routine occupations, and more strongly to the share of production routine occupations than to the share of support routine occupations.

We then add the 1982 offshorability and the 1990-2011 imports competition exposure as controls in our regression of 2011-1990 change in the share of service occupations in non-college employment and in non college unemployment rate on the initial share of routine occupations (tables 4.15 and 4.16 when splitting by support and production functions). They are positively correlated to the share of service occupations in non-college employment and to non-college unemployment. The effects of the initial share of production and support routine occupations are lower than previously but still significant. Our results for the test of the task automation hypothesis are thus still valid when we control for offshoring and imports competition.[10]

[10]But we do not rule out that globalization might have an effect too.

Table 4.14: Initial share of routine occupations and 1990-2011 imports competition exposure by employment zone

| | 1990-2011 change in imports competition exposure | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| 1982 share of routine occ. | 1.007*** | 0.396** | 1.386*** |
| | (0.207) | (0.179) | (0.387) |
| Type of routine occ. | all | support | production |
| Observations | 304 | 304 | 304 |

Source : 1982, 1990 and 2011 French Censuses, metropolitan France, insee.fr for imports data.

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

As we mentioned previously, given that the share of non-college service occupations increases more in places where the share of high-skilled occupations decreases, it is not likely that demand driven by skill-biased consumption is a major driver of our results. But demand for in-person services could also be driven by demographic changes. Increase female participation in the labor market may increase the demand for services that were previously home produced such as cleaning or childcare. The aging of the population may induce a higher demand for home care services. Although there is no obvious reason why it should be correlated to the level of the share of routine occupations in the employment zone, a spurious correlation could bias the estimations. When adding the 1982 female participation rate and the 1982 share of elderly people (over 75 year old) as control variables, results remain pretty similar for the share of service occupations in non-college employment and non-college unemployment rate (tables 4.15 and 4.16 when splitting by support and production functions) and for routine occupations (table 4.22 in appendix).

We then turn to the results on the share of high-skilled occupations. When we control for imports competition and offshoring, results are pretty similar to our main specification (table 4.17). Other competing explanations to the concentration of high-skilled workers in some zones are the functional specialization of large cities proposed by Duranton and Puga (2005) or an increase in the agglomeration economies for high-skilled jobs (Baum-Snow et al. (2014)). If zones with a high density (and thus potentially high agglomeration economies) are the same as those with a high initial level of support routine occupations, then it may bias our estimation. We therefore add the 1982 density as a control variable (table 4.17). First, we see that a higher density in 1982 is indeed significantly correlated to a higher increase in high-skilled occupations between 1990 and 2011. As high-skilled jobs are mainly support functions, it is consistent with the functional specialization of cities modeled by Duranton and Puga (2005). Second, previous

Table 4.15: Robustness of the effect of initial routine share on 1990-2011 change in low-skilled labor markets outcomes by employment zone

| | 1990-2011 change in non college empl. share of service occupations | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of routine occ. | $0.105^{***}$ | $0.123^{***}$ | $0.092^{***}$ | $0.082^{***}$ | $0.085^{***}$ |
| | $(0.023)$ | $(0.027)$ | $(0.024)$ | $(0.031)$ | $(0.029)$ |
| 1982 female participation | $-0.010$ | | | | $-0.018$ |
| | $(0.026)$ | | | | $(0.026)$ |
| 1982 share of 75 year olds | | $0.112^{**}$ | | | $0.212^{***}$ |
| | | $(0.052)$ | | | $(0.048)$ |
| 1982 offshorability index | | | $0.001$ | | $0.002^{**}$ |
| | | | $(0.001)$ | | $(0.001)$ |
| 1990-2011 change in import exposure | | | | $0.005^{***}$ | $0.009^{***}$ |
| | | | | $(0.002)$ | $(0.002)$ |
| Observations | 304 | 304 | 304 | 304 | 304 |

| | 1990-2011 change in non college unemployment rate | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of routine occ. | $0.221^{***}$ | $0.256^{***}$ | $0.164^{***}$ | $0.246^{***}$ | $0.122^{***}$ |
| | $(0.019)$ | $(0.050)$ | $(0.024)$ | $(0.048)$ | $(0.030)$ |
| 1982 female participation | $0.106^{***}$ | | | | $0.094^{***}$ |
| | $(0.022)$ | | | | $(0.027)$ |
| 1982 share of 75 year olds | | $-0.053$ | | | $0.008$ |
| | | $(0.064)$ | | | $(0.045)$ |
| 1982 offshorability index | | | $0.007^{***}$ | | $0.004^{***}$ |
| | | | $(0.001)$ | | $(0.002)$ |
| 1990-2011 change in import exposure | | | | $0.006^{**}$ | $0.011^{***}$ |
| | | | | $(0.003)$ | $(0.003)$ |
| Observations | 304 | 304 | 304 | 304 | 304 |

Source : 1982, 1990 and 2011 French Censuses, metropolitan France.

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

Table 4.16: Robustness of the effect of initial share of support and production routine occupations on 1990-2011 change in low-skilled labor markets outcomes by employment zone

| | 1990-2011 change in the share of service occupations in non-college employment | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of | $0.148^{***}$ | $0.161^{***}$ | $0.140^{***}$ | $0.104^{***}$ | $0.083^{***}$ |
| production routine occ. | $(0.024)$ | $(0.024)$ | $(0.023)$ | $(0.027)$ | $(0.024)$ |
| 1982 share of | $0.084^{**}$ | $0.110^{***}$ | $0.039$ | $0.078^{**}$ | $0.086^{*}$ |
| support routine occ. | $(0.035)$ | $(0.040)$ | $(0.044)$ | $(0.038)$ | $(0.048)$ |
| 1982 female | $0.006^{*}$ | | | | $-0.018$ |
| participation | $(0.030)$ | | | | $(0.025)$ |
| 1982 share | | $0.103^{*}$ | | | $0.214^{***}$ |
| of 75 year olds | | $(0.057)$ | | | $(0.060)$ |
| 1982 offshorability | | | $0.003$ | | $0.002$ |
| index | | | $(0.002)$ | | $(0.001)$ |
| 1990-2011 change in | | | | $0.005^{***}$ | $0.009^{***}$ |
| import exposure | | | | $(0.002)$ | $(0.002)$ |
| Observations | 304 | 304 | 304 | 304 | 304 |

| | 1990-2011 change in non college unemployment rate | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of | $0.236^{***}$ | $0.217^{***}$ | $0.201^{***}$ | $0.147^{***}$ | $0.125^{***}$ |
| production routine | $(0.031)$ | $(0.031)$ | $(0.029)$ | $(0.035)$ | $(0.037)$ |
| 1982 share of | $0.213^{***}$ | $0.269^{***}$ | $0.123^{***}$ | $0.263^{***}$ | $0.119^{***}$ |
| support routine occ. | $(0.024)$ | $(0.054)$ | $(0.036)$ | $(0.042)$ | $(0.038)$ |
| 1982 female | $0.112^{***}$ | | | | $0.094^{***}$ |
| participation | $(0.025)$ | | | | $(0.027)$ |
| 1982 share | | | | | $0.005$ |
| of 75 year olds | | $(-0.0430.067)$ | | | $(0.049)$ |
| 1982 offshorability | | | $0.008^{***}$ | | $0.004^{**}$ |
| index | | | $(0.001)$ | | $(0.002)$ |
| 1990-2011 change in | | | | $0.009^{***}$ | $0.011^{***}$ |
| import exposure | | | | $(0.003)$ | $(0.003)$ |
| Observations | 304 | 304 | 304 | 304 | 304 |

Source : 1982, 1990 and 2011 French Censuses, metropolitan France, insee.fr for imports data.

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

results hold. The share of high-skilled occupations increased more in the zones where the share of support routine occupations was high and not where the share of production routine occupations was high. So the evidence of a spatial complementarity between support routine tasks and abstract tasks remains.

Table 4.17: Robustness of the effect of initial share of support and production routine occupations on 1990-2011 change in the share of high-skilled occupations by employment zone

| | 1990-2011 change in the share of high-skilled occupations | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| 1982 share of | $-0.055^{*}$ | $-0.041$ | $-0.018$ | $-0.075^{**}$ |
| production routine occ. | $(0.029)$ | $(0.039)$ | $(0.042)$ | $(0.032)$ |
| 1982 share of | $0.198^{***}$ | $0.327^{***}$ | $0.618^{***}$ | $0.166^{***}$ |
| support routine occ. | $(0.065)$ | $(0.081)$ | $(0.213)$ | $(0.059)$ |
| 1982 density | $0.013^{***}$ | | | $0.012^{***}$ |
| | $(0.001)$ | | | $(0.001)$ |
| 1982 offshorability | | $0.015^{***}$ | | $0.002$ |
| index | | $(0.006)$ | | $(0.003)$ |
| 2011-1990 change in | | | $0.002$ | $0.002$ |
| import exposure | | | $(0.003)$ | $(0.002)$ |

Source : 1982, 1990 and 2011 French Censuses, metropolitan France, insee.fr for imports data.

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

# Conclusion

We find evidence of the automation of tasks, both in production and support functions, in France over 1990-2011. More precisely, we find evidence that with ICT development, low-skilled workers switch from routine tasks to service occupations (manual tasks), or to unemployment. This could explain the skill-biased demand shift and its spatial component documented in the previous chapters.

At the same time, a functional specialization of local labor markets seems to have occurred over the period 1990-2001 and probably contributed to this spatial shift. High-skilled jobs concentrated in zones where the share of high-skilled occupations was initially higher, and where support routine jobs were also over-represented.

We show that these results are robust to alternative explanations such as the offshoring of jobs, imports competition, or agglomeration economies, although we do not exclude that these

may play a role too. But assessing these other explanations is beyond the scope of this analysis and left for further research.

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# Appendices

## 4.A Occupations and tasks

We match the French classification of occupations with data published by Autor and Dorn (2013), itself based on Autor et al. (2003). They compute this data using the US Department of Labor's *Dictionnary of Occupational Titles* (DOT) and obtain measures of task contents for each occupation that they divide in abstract, routine and manual tasks. We match the US classification with the 1982 French classification of occupations and thus obtain measures of abstract, routine and manual tasks for each occupation. Doing this, we assume that the tasks of jobs with a similar denomination in the French and US classification are similar. Another important point is that the task contents of occupations may evolve. In particular, tasks of occupations with high routine contents may be upgraded with the development of computer without changing denomination. This is not taken into account in the Autor and Dorn (2013) measure, which is based on 1977 DOT, but this methodology is conservative as it probably underestimates the decline in routine tasks. Note that we use the task intensity only to classify occupations in 1982 and then we analyze the variations in the share of different occupations.

We also separate occupations between support and production functions as an application of Duranton and Puga (2005) theoretical model. Table 4.18 presents the social category in the 1982 French classification that we define as support functions. We choose management, administrative functions and medium-skilled commercial functions when the main activity of the firm is not trade. We consider for the latter that they are a support function to the other main activity of the firm in that case.

Table 4.18: Occupations defined as support functions

| 1982 social category | Description |
|---|---|
| 23 | Heads of firm of more than 10 employees |
| 33 | Public managers |
| 37 | Administrative and commercial managers |
| 38 | Engineers and technical executives |
| 45 | Medium qualified administrative jobs in public sector |
| 46 | Administrative and commercial medium qualified<br>except artistic technicians and tourism and catering jobs<br>and not working in the trade sector |
| 52 | Employees in public sector,<br>except 5216, 5217, 5221, 5222, 5223, 5445 (health and maintenance jobs) |
| 54 | Administrative employees |

Table 4.19: Occupations defined as high-skilled (1)

| 1982 social category | Description |
|---|---|
| 2244 | Indépendants gestionnaires de spectacle ou de service récréatif, de 0 à 9 salariés |
| 2246 | Indépendants gestionnaires d'établissement privé d'enseignement, de santé, d'action sociale, de 0 à 9 salariés |
| 2310 | Salariés chefs d'entreprise |
| 2320 | Salariés chefs d'entreprise |
| 2331 | Salariés chefs d'entreprise |
| 2332 | Salariés chefs d'entreprise |
| 2333 | Salariés chefs d'entreprise |
| 2334 | Salariés chefs d'entreprise |
| 3111 | Médecins libéraux spécialistes |
| 3112 | Médecins libéraux généralistes |
| 3113 | Chirurgiens-dentistes (libéraux ou salariés) |
| 3114 | Psychologues, psychanalystes, psychothérapeutes (non médecins) |
| 3115 | Vétérinaires (libéraux ou salariés) |
| 3116 | Pharmaciens libéraux |
| 3121 | Avocats |
| 3122 | Notaires |
| 3123 | Conseils juridiques et fiscaux, libéraux |
| 3124 | Experts comptables, comptables agréés, libéraux |
| 3125 | Ingénieurs conseils libéraux en recrutement, organisation, études économiques |
| 3126 | Ingénieurs conseils libéraux en études techniques |
| 3127 | Architectes libéraux |
| 3128 | Huissiers de justice, officiers ministériels et professions libérales diverses |
| 3130 | Aides familiaux non salariés de professions libérales effectuant un travail administratif |
| 3311 | Personnels de direction de la fonction publique |
| 3312 | Ingénieurs de l'état et des collectivités locales |
| 3313 | Magistrats |
| 3314 | Inspecteurs et autres cadres A des Impôts, du trésor et des Douanes |
| 3315 | Inspecteurs et autres cadres A des PTT |
| 3316 | Personnels administratifs supérieurs des collectivités locales et hopitaux publics |
| 3317 | Personnels administratifs de catégorie A de l'Etat (sauf Impôts, Trésor, Douanes, PTT) |
| 3318 | Personnes exercant un mandat politique ou syndical |
| 3321 | Officiers de l'armée et de la gendarmerie (sauf généraux) |
| 3411 | Professeurs agrégés et certifiés |
| 3414 | Directeurs d'établissement d'enseignement secondaire et inspecteurs |
| 3415 | Enseignants de l'enseignement supérieur |
| 3421 | Chercheurs de la recherche publique |
| 3431 | Médecins hospitaliers |
| 3432 | Médecins non hospitaliers |
| 3433 | Psychologues spécialistes de l'orientation scolaire et professionnelle |
| 3434 | Etudiants hospitaliers, stagiaires internes |
| 3435 | Pharmaciens |
| 3511 | Journalistes, secrétaires de rédaction |
| 3512 | Auteurs littéraires, scénaristes, dialoguistes |
| 3513 | Bibliothécaires, archivistes, conservateurs, de la fonction publique |
| 3521 | Cadres de la presse, de l'édition, de l'audiovisuel et des spectacles |
| 3522 | Cadres artistiques des spectacles |
| 3523 | Cadres techniques de la réalisation des spectacles vivants et audiovisuels |
| 3531 | Artistes plasticiens |
| 3532 | Artistes professionnels de la musique et du chant |
| 3533 | Artistes dramatiques, danseurs |
| 3534 | Professeurs d'art (hors établissements scolaires) |
| 3535 | Artistes de variétés |

Table 4.20: Occupations defined as high-skilled (2)

| 1982 social category | Description |
|---|---|
| 3710 | Cadres d'état-major administratifs, financiers, commerciaux des grandes entreprises |
| 3721 | Cadres chargés d'études économiques, financières, commerciales |
| 3722 | Cadres spécialistes du recrutement, de la formation |
| 3723 | Cadres de l'organisation, du contrôle des services administratifs, financiers |
| 3724 | Cadres de gestion courante des services financiers, comptables des grandes entreprises |
| 3725 | Cadres de gestion courante des services du personnel des grandes entreprises |
| 3726 | Cadres de gestion courante des autres services administratifs des grandes entreprises |
| 3727 | Cadres administratifs ou financiers des petites et moyennes entreprises |
| 3728 | Cadres de la documentation, de l'archivage |
| 3731 | Cadres de l'exploitation des magasins de vente |
| 3732 | Chefs de produits, acheteurs du commerce et autres cadres de la mercatique |
| 3733 | Cadres des ventes des grandes entreprises (hors commerce de détail) |
| 3734 | Cadres commerciaux des PME (hors commerce de détail) |
| 3735 | Cadres de la publicité ; cadres des relations publiques |
| 3741 | Cadres des services techniques et commerciaux de la banque |
| 3744 | Cadres des services techniques des assurances |
| 3751 | Cadres de l'hôtellerie et de la restauration |
| 3810 | Directeurs techniques des grandes entreprises |
| 3820 | Ingénieurs, cadres d'études, développement de l'agriculture, des eaux et forêts |
| 3821 | Ingénieurs, cadres de recherche, études, essais en électricité, électronique |
| 3822 | Ingénieurs et cadres de bureau d'études ou des méthodes en mécanique |
| 3823 | Ingénieurs, cadres d'études, méthodes, contrôles en Bâtiment et Travaux Publics |
| 3824 | Architectes salariés |
| 3825 | Ingénieurs et cadres de recherche, développement en chimie, biologie |
| 3826 | Ingénieurs et cadres de recherche, développement, contrôles en métallurgie |
| 3827 | Ingénieurs et cadres de recherche, études des industries légères |
| 3828 | Ingénieurs et cadres spécialistes de l'informatique (sauf technico-commerciaux) |
| 3829 | Autres ingénieurs et cadres d'études |
| 3831 | Ingénieurs et cadres de fabrication en matériel électrique, électronique |
| 3832 | Ingénieurs et cadres de fabrication en mécanique |
| 3833 | Ingénieurs et cadres de chantier du bâtiment et du génie civil |
| 3835 | Ingénieurs et cadres de fabrication en chimie et agroalimentaire |
| 3836 | Ingénieurs et cadres de fabrication en métallurgie, verre, matériaux |
| 3837 | Ingénieurs et cadres de fabrication des industries légères |
| 3838 | Cadres techniques de l'imprimerie et de l'édition |
| 3839 | Ingénieurs et cadres de la production et distribution d'électricité, gaz, eau |
| 3841 | Ingénieurs et cadres d'entretien, travaux neufs |
| 3842 | Ingénieurs et cadres des achats et approvisionnements industriels |
| 3843 | Ingénieurs et cadres de planning, ordonnancement |
| 3851 | Ingénieurs et cadres technico-commerciaux en matériel électrique ou électronique professionnel |
| 3852 | Ingénieurs, cadres technico-commerciaux en matériel mécanique professionnel |
| 3853 | Ingénieurs et cadres technico-commerciaux en bâtiment, génie civil |
| 3854 | Ingénieurs et cadres technico-commerciaux en biens intermédiaires |
| 3855 | Ingénieurs et cadres technico-commerciaux en informatique |
| 3861 | Cadres des transports et de la logistique |
| 3862 | Personnels navigants techniques de l'aviation civile |
| 3863 | Officiers de la marine marchande |
| 4211 | Instituteurs |
| 4214 | Directeurs d'école primaire ou de maternelle |
| 4215 | Instituteurs de l'éducation spécialisée |
| 4221 | PEGC et matres auxiliaires de l'enseignement général |
| 4224 | Enseignants du technique court |
| 4227 | Conseillers d'éducation et surveillants |
| 4231 | Assistants techniques de la documentation, de l'archivage |
| 4232 | Formateurs et animateurs de formation continue |
| 4233 | Moniteurs et éducateurs sportifs, sportifs professionnels |

Table 4.21: Occupations defined as low-skilled service occupations

| 1982 social category | Description |
|---|---|
| 2101 | Artisans boulangers, pâtissiers, de 0 à 2 salariés |
| 2102 | Artisans boulangers, pâtissiers, de 3 à 9 salariés |
| 2103 | Artisans bouchers, de 0 à 2 salariés |
| 2104 | Artisans bouchers, de 3 à 9 salariés |
| 2105 | Artisans charcutiers, de 0 à 2 salariés |
| 2106 | Artisans charcutiers, de 3 à 9 salariés |
| 2107 | Autres artisans de l'alimentation |
| 2171 | Conducteurs de taxi artisans |
| 2172 | Artisans coiffeurs, manucures, esthéticiens |
| 2173 | Artisans teinturiers, blanchisseurs |
| 2174 | Artisans des services divers |
| 2181 | Transporteurs routiers Indépendants, de 0 à 3 salariés |
| 2182 | Bateliers Indépendants, de 0 à 9 salariés |
| 2190 | Aides familiaux non salariés ou associés d'artisans effectuant un travail administratif ou commercial |
| 4311 | Cadres infirmiers et assimilés |
| 4312 | Infirmiers psychiatriques |
| 4313 | Puéricultrices |
| 4314 | Infirmiers spécialisés (autres que puéricultrices) |
| 4315 | Infirmiers en soins généraux |
| 4316 | Infirmiers libéraux |
| 4321 | Sages-femmes |
| 4322 | Spécialistes de la rééducation et diététiciens |
| 4323 | Spécialistes de la rééducation et pédicures, libéraux |
| 4324 | Techniciens médicaux |
| 4325 | Spécialistes de l'appareillage médical |
| 4326 | Spécialistes de l'appareillage médical. Indépendants |
| 4327 | Préparateurs en pharmacie |
| 4331 | Assistantes sociales |
| 4332 | Educateurs spécialisés |
| 4333 | Animateurs socioculturels et de loisirs |
| 4334 | Conseillers familiaux |
| 4411 | Clergé séculier |
| 4412 | Clergé régulier |
| 5216 | Agents de service des établissements d'enseignement |
| 5217 | Agents de service de la fonction publique (sauf écoles, hôpitaux) |
| 5221 | Aides-soignants |
| 5222 | Agents de service hospitaliers |
| 5223 | Ambulanciers |
| 5311 | Agents de police |
| 5312 | Gendarmes |
| 5313 | Sergents |
| 5314 | Hommes du rang |
| 5315 | Pompiers |
| 5316 | Agents techniques des eaux et forêts |
| 5317 | Agents de sécurité, de surveillance |
| 5445 | Agents et hôtesses d'accompagnement (transports, tourisme) |
| 5611 | Serveurs et commis de restaurant ou de café |
| 5614 | Employés de l'hôtellerie |
| 5621 | Manucures, esthéticiennes |
| 5622 | Coiffeurs |
| 5631 | Assistantes maternelles, gardiennes d'enfants, travailleuses familiales |
| 5632 | Employés de maison et femmes de ménages chez des particuliers |
| 5633 | Concierges, gardiens d'immeubles |
| 5634 | Employés des services divers |
| 6301 | Jardiniers |
| 6351 | Bouchers (sauf industrie de la viande) |
| 6352 | Charcutiers (sauf industrie de la viande) |
| 6353 | Boulangers, pâtissiers (sauf activité industrielle) |
| 6354 | Cuisiniers qualifiés |
| 6411 | Conducteurs routiers et grands routiers |
| 6412 | Conducteurs de véhicule routier de transport en commun |
| 6413 | Conducteurs de taxi |
| 6414 | Conducteurs de voiture particulière |
| 6415 | Conducteurs-livreurs, coursiers |
| 6851 | Apprentis boulangers, bouchers, charcutiers |
| 6891 | Nettoyeurs |

## 4.B Imports competition and ICT dissemination exposure index

We compute two other indexes using data from the French National Accounts (insee.fr) for the years we study (1982, 1990 and 2011).

We compute an index of imports competitions exposure, very similar to Autor et al. (2013a). We do not use China's exports as an instrument as the purpose here is not to estimate the effects of imports competition, but to control for it. Malgouyres (2014) did such an instrumentation for the French case. We use data on imports in goods and services (chain-linked volumes) and compute the imports per employment at a national level for each year and each industry. The finest level common to this data and the Censuses data was of 21 industries, of which 11 are in manufacturing. For each employment zone, we compute the average across industries of this measure for each year, weighting by the 1982 employment share of each industry in the employment zone. Thus this index measures how much the 1982 employment of a zone was exposed to imports competition given the subsequent national trends of imports and given the 1982 distribution of employment by industry.

We also compute an index to measure ICT dissemination exposure in an employment zone. We use the end-of the year fixed net capital in ICT (previous year's prices and chain-linked volumes) by industry by year. We computed ICT per worker per year at a national level and then, for each employment zone, we compute the average across industries of this measure for each year, weighting by the 1982 employment share of each industry in the employment zone. Thus this index measures how much the 1982 employment of a zone was exposed to ICT dissemination given the national trends and given the 1982 distribution of employment by industry.

# 4.C Additional table

Table 4.22: Robustness of the effect of initial share of routine occupations on 1990-2011 change in the share of routine occupations by employment zone

| | 1990-2011 change in the share of routine occupations in employment | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of routine occ. | $-0.340^{***}$ | $-0.365^{***}$ | $-0.347^{***}$ | $-0.348^{***}$ | $-0.357^{***}$ |
| | (0.022) | (0.019) | (0.029) | (0.016) | (0.030) |
| 1982 female participation | $-0.030$ | | | | $-0.060^{**}$ |
| | (0.024) | | | | (0.026) |
| 1982 share of 75 year olds | | $-0.059$ | | | $-0.085^{**}$ |
| | | (0.038) | | | (0.035) |
| 1982 offshorability index | | | 0.000 | | $0.002^{*}$ |
| | | | (0.001) | | (0.001) |
| 1990-2011 change in import exposure | | | | $-0.001$ | $-0.004^{**}$ |
| | | | | (0.002) | (0.002) |
| Observations | 304 | 304 | 304 | 304 | 304 |

| | 1990-2011 change in the share of support routine occ. in employment | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of support routine occ. | $-0.272^{***}$ | $-0.298^{***}$ | $-0.269^{***}$ | $-0.290^{***}$ | $-0.278^{***}$ |
| | (0.019) | (0.017) | (0.028) | (0.015) | (0.033) |
| 1982 female participation | $-0.030^{*}$ | | | | $-0.027$ |
| | (0.018) | | | | (0.017) |
| 1982 share of 75 year olds | | $-0.039$ | | | $-0.020$ |
| | | (0.027) | | | (0.032) |
| 1982 offshorability index | | | $-0.001$ | | 0.00002 |
| | | | (0.001) | | (0.001) |
| 1990-2011 change in import exposure | | | | 0.001 | 0.0002 |
| | | | | (0.001) | (0.001) |
| Observations | 304 | 304 | 304 | 304 | 304 |

| | 1990-2011 change in the share of production routine occ. in employment | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| 1982 share of production routine occ. | $-0.438^{***}$ | $-0.419^{***}$ | $-0.435^{***}$ | $-0.414^{***}$ | $-0.435^{***}$ |
| | (0.019) | (0.021) | (0.020) | (0.023) | (0.022) |
| 1982 female participation | $-0.045^{***}$ | | | | $-0.028^{*}$ |
| | (0.010) | | | | (0.015) |
| 1982 share of 75 year olds | | 0.030 | | | 0.013 |
| | | (0.024) | | | (0.025) |
| 1982 offshorability index | | | $-0.002^{***}$ | | $-0.001^{*}$ |
| | | | (0.001) | | (0.001) |
| 1990-2011 change in import exposure | | | | $-0.001$ | $-0.0005$ |
| | | | | (0.002) | (0.002) |
| Observations | 304 | 304 | 304 | 304 | 304 |

Source : 1982, 1990 and 2011 French Censuses, metropolitan France, insee.fr for imports data.

Note: Standard errors in parentheses. Estimations are weighted by 1982 employment zone population. * $p < 0.10$. ** $p < 0.05$. *** $p < 0.01$.

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**Titre :** Inégalités, qualifications et géographie des emplois sur le marché du travail en France
**Mots clés :** politique de la ville, zones franches urbaines, TGV, inégalités de salaires, progrès technique biaisé, marchés locaux du travail

**Résumé :** Cette thèse étudie les déterminants de la localisation des emplois, des travailleurs et des entreprises en France.
Le chapitre 1 évalue l'effet des Zones Franches Urbaines sur leurs habitants. Il montre d'une part que cette politique a réduit de manière significative le chômage des résidents, du fait notamment de la présence d'une clause d'embauche locale et, d'autre part, qu'elle a occasionné à long terme des effets de recomposition sociale des quartiers ciblés, dont elle a accru la part de travailleurs qualifiés. Le chapitre 2 mesure l'impact sur le management des entreprises du temps de trajet entre les filiales et leur siège social. Il montre que les filiales que le TGV a permis de relier plus rapidement à leur siège social ont réduit la proportion de managers dans leur main d'œuvre et se sont concentrées sur leurs activités de production.
Le chapitre 3 décrit la baisse du salaire relatif des travailleurs qualifiés et l'augmentation parallèle de l'offre relative de travail qualifié qui s'est produite en France pour les hommes de 15 à 65 ans entre 1967et 2009. Il montre que l'augmentation du niveau d'éducation a masqué une réorientation de la demande de travail vers les plus qualifiés d'une ampleur égale au moins à la moitié ce qui a été observé aux États-Unis.
Une analyse complémentaire est ensuite conduite au niveau des marchés locaux du travail, afin de décrire les dynamiques spatiales de l'offre de travail et des inégalités de salaires par niveau d'éducation en France sur la période 1982-2011. Elle montre que les travailleurs les plus diplômés se sont concentrés géographiquement et que la demande de travailleurs qualifiés a évolué différemment suivant les territoires. Le chapitre 4 s'appuie sur les dynamiques spatiales des salaires et de l'offre et la demande de travail pour tester l'hypothèse selon laquelle le progrès technique et l'informatisation biaiserait la demande de travail vers les qualifiés. Plus précisément, il montre que les emplois routiniers ont plus décru dans les marchés du travail où leur part était initialement élevée, mais que les emplois abstraits n'y ont pas augmenté comme c'est le cas aux États-Unis. Il montre ensuite que l'effet des nouvelles technologies sur les emplois routiniers et abstraits varie avec le type de fonction occupée : support ou de production.

**Title :** Labor market inequalities, skills and the geography of jobs: French evidence
**Keywords :** urban policy, enterprise zones, high speed rail, wage inequalities, skill-biased technical change, local labor markets.

**Abstract:** This thesis investigates the determinants of jobs', workers' and firms' location decisions in France.
The first chapter evaluates the impact of French enterprise zones on their residents. It shows that this program reduced significantly the unemployment rate of residents due, in part, to the fact that firms' payroll exemptions were made conditional on local hiring. It also shows that social composition effects occurred in the long run, and that the program increased the share of high-skilled workers in enterprise zones. The second chapter documents the impact of rail travel time on the management of French multi-plant businesses. It shows that affiliates which benefited from new High Speed Rail lines to relate faster to their headquarters reorganized and decreased the share of managers in the workforce, while refocusing on their production activity.
The third chapter documents a strong decrease in the high-skilled/low-skilled relative wage that occurred concomitantly with a strong increase in the relative labor supply for male aged 15-65 in France in the last 40 years.
It shows that the increase in educational attainment has hidden the effects of a skill-biased demand shift, which are found to be of at least half of those found in the U.S. An additional analysis is conducted at the level of local labor markets. It investigates the spatial trends of education supply and wage inequalities by education levels and shows that a spatial concentration of educated workers and a skill-biased spatial shift in demand occurred in France between 1982 and 2011. The fourth chapter uses the spatial dynamics of wage, labor supply and labor demand to test the "computerization" hypothesis for France on the period 1990-2011. It shows that jobs with codifiable or routine tasks declined more on the labor markets where their share in employment was initially higher, but that abstract jobs did not increase in the same places, like in the US. It then shows that skill-biased technical change affects the spatial distribution of routine and abstract jobs according to the function performed: support or production.

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**Inégalités, qualifications et géographie des emplois sur le marché du travail en France**

Cette thèse étudie les déterminants de la localisation des emplois, des travailleurs et des entreprises en France.

Le chapitre 1 évalue l'effet des Zones Franches Urbaines sur leurs habitants. Il s'appuie sur les données des enquêtes Emploi de 1993 à 2007 et la méthodologie des différences de différences. Il montre d'une part que cette politique a réduit de manière significative le chômage des résidents dans ces quartiers, du fait notamment de la présence d'une clause d'embauche locale et, d'autre part, qu'elle a occasionné à long terme des effets de recomposition sociale des quartiers ciblés, dont elle a accru la part de travailleurs qualifiés.

Le chapitre 2 mesure l'impact sur le management des entreprises du temps de trajet entre les filiales et leur siège social. Il s'appuie sur des données administratives couvrant l'ensemble des entreprises du secteur privé sur le territoire français entre 1993 et 2011, et compare des filiales dont le temps de trajet vers leur siège social a été affecté par l'ouverture d'une ligne TGV avec des filiales du même marché local dont le temps de trajet vers leur siège social n'a pas été affecté. Les résultats montrent que les filiales que le TGV a permis de relier plus rapidement à leur siège social ont réduit la proportion de managers dans leur main d'œuvre et se sont concentrées sur leurs activités de production. Cela semble s'être traduit aussi par une augmentation de la part des managers de l'entreprise localisés au siège social et du taux de profit de l'entreprise dans son ensemble.

Le chapitre 3 s'appuie sur des données administratives permettant de décrire les salaires du secteur privé par niveau d'éducation depuis 1967 en France et sur l'estimation d'un modèle d'offre et de demande de travail déjà testé sur données américaines. Il décrit la baisse du salaire relatif des travailleurs qualifiés et l'augmentation parallèle de l'offre relative de travail qualifié qui s'est produite en France pour les hommes de 15 à 65 ans entre 1967 et 2009. Il montre que l'augmentation du niveau d'éducation a masqué une réorientation de la demande de travail vers les plus qualifiés d'une ampleur égale au moins à la moitié de ce qui a été observé aux États-Unis. Si la demande continue à évoluer sur cette tendance alors que le niveau d'éducation se stabilise, il est probable que la France connaisse une augmentation des inégalités salariales similaire à celle observée aux États-Unis. Une analyse complémentaire est ensuite conduite au niveau des marchés locaux du travail, afin de décrire les dynamiques

spatiales de l'offre de travail et des inégalités de salaires par niveau d'éducation en France sur la période 1982-2011. Elle montre que les travailleurs les plus diplômés se sont concentrés géographiquement et que la demande de travailleurs qualifiés a évolué différemment suivant les territoires. Cela a conduit à une convergence spatiale des différences de salaires entre travailleurs plus et moins diplômés. Cependant si les dynamiques spatiales de l'offre et la demande de travail qualifié se maintiennent, une divergence pourrait se produire comme cela est déjà le cas aux États-Unis.

Le chapitre 4 s'appuie sur les dynamiques spatiales des salaires et de l'offre et la demande de travail pour tester l'hypothèse selon laquelle le progrès technique et l'informatisation biaiserait la demande de travail vers les plus qualifiés. Selon cette hypothèse, le capital informatique se substitue aux tâches routinières alors qu'il est complémentaire des tâches abstraites. L'impact des nouvelles technologies sur différents marchés locaux du travail varierait donc en fonction de l'importance des taches routinières dans l'emploi local avant leur diffusion. Plus précisément, ce chapitre montre que les emplois routiniers ont plus décru dans les marchés du travail où leur part était initialement élevée, mais que les emplois abstraits n'y ont pas augmenté comme c'est le cas aux États-Unis. Cela s'y est aussi traduit pour les moins qualifiés par une plus forte part d'emplois dans les services et plus de chômage. Il montre ensuite que l'effet des nouvelles technologies sur les emplois routiniers et abstraits varie avec le type de fonction occupée : support ou production. Enfin, la prise en compte des effets potentiels de la mondialisation, autre candidat à l'explication des dynamiques observées, ne remet pas en cause ces résultats.